YOKOGAWA

**NORTHERN TECHNICAL SALES**
DIVISION OF NTS ASSOCIATES

**Brian R. Fox**
Sales Engineer

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YOKOGAWA

Yokogawa Corporation of America
2 Dart Road
Shenandoah Industrial Park
Newnan, GA 30265-1094

Telephone: 404-253-7000
Telex: 244880
Telefax: 404-251-2088

Date: December 19, 91

To: Northern Technical Sales
101 Old Cove Rd. Ste. 114
Liverpool, NY 13090

Subj: Instructions for Placing and Maintaining this T & M Master Binder, Serial Number T-1626

This T & M Master Binder is currently charged out to you. A replacement binder will be supplied to you ONLY after YCA has received this letter filled in as requested.

Before you reassign this T & M Master Binder to a LARGE T & M CUSTOMER, please comply with the following instructions:

1. Remove this letter from the T & M Master Binder.

2. Fill in all the information below and return this letter to:

Yokogawa Corporation of America
Attn: Literature Department
2 Dart Road
Newnan, GA 30265

This T & M Master Binder has been reassigned and additions and updates should be sent to the following customer (please type or print clearly):

Binder S/N: T-1626 Representative Code: NTS

Name: ____________________

Company: ____________________

Address: ____________________

City: ____________________

State: ____________ Zip: ____________

Phone: (________) ____________________

Your compliance with the instructions above will allow YCA to properly maintain this T & M Master Binder.

Best Regards,

JoAnn Ferguson
Literature Clerk

YOKOGAWA ◆

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Norcross, GA 30092
404/449-4155

### ALASKA
**BRETT ASSOCIATES, INC.**
Seattle, WA 98102
206/328-6900

### ARIZONA
**TREMBLY ASSOCIATES, INC.**
Tempe, AZ 85282
602/967-2058

### ARKANSAS
**BEACON MICROWAVE**
Dallas, TX 75243
214/437-1505

### CALIFORNIA
(North)
**AMASCO**
San Jose, CA 95131
408/262-1500
(South)
**TECHNOLOGIES WEST**
Simi Valley, CA 93063
818/700-6426

### COLORADO
**TREMBLY ASSOCIATES, INC.**
Wheat Ridge, CO 80033
303/421-8900

### CONNECTICUT
(Fairfield County)
**RADIATION ELECTRONICS**
Port Chester, NY 10573
914/937-2300
(All except Fairfield
County)
**PAT ASSOCIATES**
Narragansett, RI 02882
401/783-9598

### DELAWARE
**CEMTECH-ENERGY CONTROLS**
Broomall, PA 19008
215/356-9510

### DISTRICT OF COLUMBIA
**EASTERN INSTRUMENTATION**
Burtonsville, MD 20866
301/384-8500

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### GEORGIA
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Norcross, GA 30092
404/449-4155

### HAWAII
**YOKOGAWA CORP. OF AMERICA**
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714/220-2022

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(South)
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801/295-4703

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**SECTOR ENG. SALES, INC.**
Elmhurst, IL 60126
708/530-7850
(South)
**TECREP CORPORATION**
St. Louis, MO 63108
314/454-9110

### INDIANA
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Counties)
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Elmhurst, IL 60126
708/530-7850
(All except Lake, Porter
and LaPorte Counties)
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317/773-2752

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(Southwest)
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314/454-9110
(Southeast)
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708/530-7850

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**TECREP CORPORATION**
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801/295-4703
(North)
**BRETT ASSOCIATES, INC.**
Seattle, WA 98102
206/328-6900

### NEBRASKA
**TECREP CORPORATION**
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314/454-9110

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(North)
**PACIFIC COAST MARKETING**
Los Gatos, CA 95030
408/370-3505
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**TECHNOLOGIES WEST**
Simi Valley, CA 93063
818/700-6426

### NEW HAMPSHIRE
**PAT ASSOCIATES**
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401/783-9598

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(North)
**RADIATION ELECTRONICS**
Port Chester, NY 10573
914/937-2300
(South)
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Broomall, PA 19008
215/356-9510

### NEW MEXICO
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Albuquerque, NM 87108
505/266-8616

8/1/91

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**NORTHERN TECHNICAL SALES**
Liverpool, NY 13090
315/451-1091
(Metro New York)
**RADIATION ELECTRONICS**
Port Chester, NY 10573
914/937-2300

### NORTH CAROLINA
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**DYTEC INSTRUMENTS, INC.**
Edina, MN 55435
612/831-7169

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215/356-9510
(West)
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412/459-8090

### PUERTO RICO
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809/728-5040

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404/449-4155

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505/266-8616
(North)
**BEACON MICROWAVE**
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214/437-1505

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301/384-8500

### WASHINGTON
**BRETT ASSOCIATES, INC.**
Seattle, WA 98102
206/328-6900

### WEST VIRGINIA
**MEASUREMENT INSTRUMENTS EAST**
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412/459-8090

### WISCONSIN
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**RAECO, INC.**
Chicago Heights, IL 60411
708/754-4800
(West)
**DYTEC INSTRUMENTS INC.**
Edina, MN 55435
612/831-7169

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**TREMBLY ASSOCIATES, INC.**
Wheat Ridge, CO 80033
303/421-8900

### CANADA

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**R.H.NICHOLS CO. LTD.**
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416/851-8871

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**R.H. NICHOLS CO. LTD.**
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514/337-0425

(Northeast Ontario & Northwest Quebec)
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613/727-3974

(British Columbia & Yukon)
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604/980-8505

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403/259-6220
(North Alberta)
**C.B. ENGINEERING, LTD.**
Edmonton, Alberta T6A 0L4
403/465-9370

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**EQUILAB**
Caracas, Venezuela
582-239-3233

### MEXICO
**TESA**
Mexico City, Mexico
525-781-4300

### REGIONAL OFFICES

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404/253-7000

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**YOKOGAWA CORP. OF AMERICA**
Newnan, GA 30265
404/253-7000

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**YOKOGAWA CORP. OF AMERICA**
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401/539-1008

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**YOKOGAWA CORP. OF AMERICA**
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619/451-6792

### CORPORATE HEADQUARTERS

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Shenanadoah Industrial Park
Newnan, GA 30265
404/253-7000

YOKOGAWA

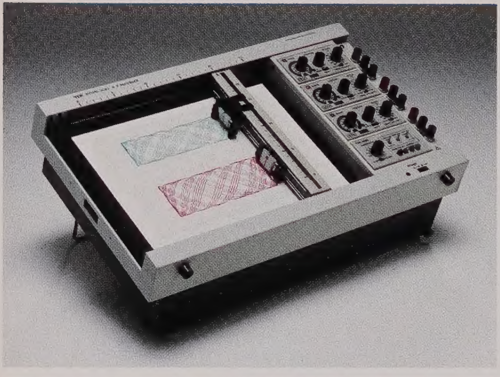
**Yokogawa Corporation of America**
**2 Dart Road**
**Shenandoah Industrial Park**
**Newnan, GA 30265**

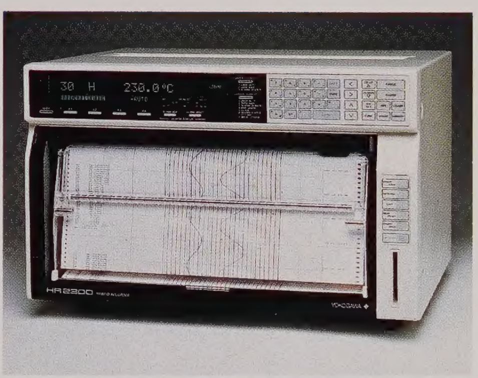
**Tel.: 404/253-7000**
**Fax.: 404/251-2088**

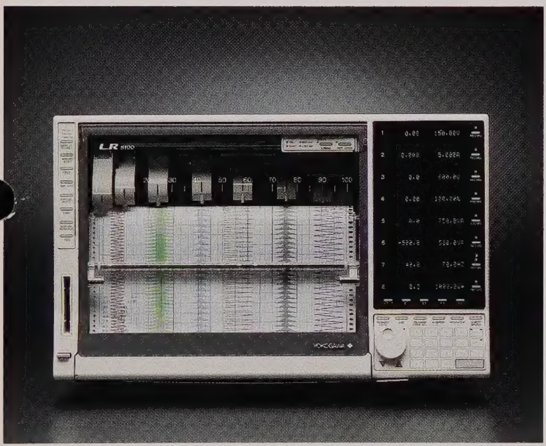
YOKOGAWA ◆

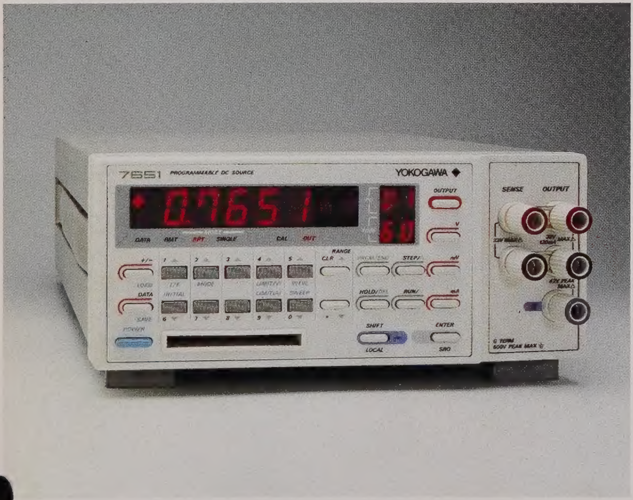
# Measuring Instruments

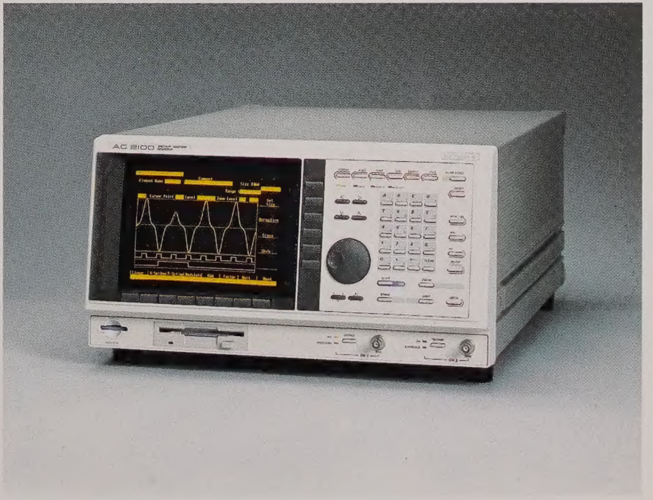
## Short Form











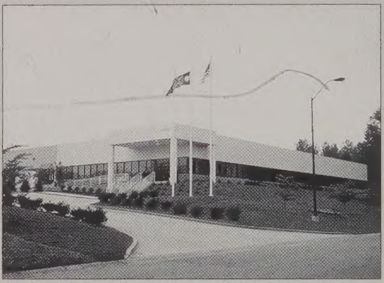
# A WORLDWIDE CAPABILITY

YOKOGAWA has been Japan's foremost leader in the field of measuring instruments, process control equipment and industrial computers for over seventy years. YOKOGAWA is continuing to contribute to society through broad-ranging activities in the areas of measurement, control, and information.

We have the resources and wide range of advanced products to offer a total solution to your needs. For example, our line of measuring instruments provides complete support for complex measurement, testing, and analysis over a broad field ranging from research and development to production and servicing.

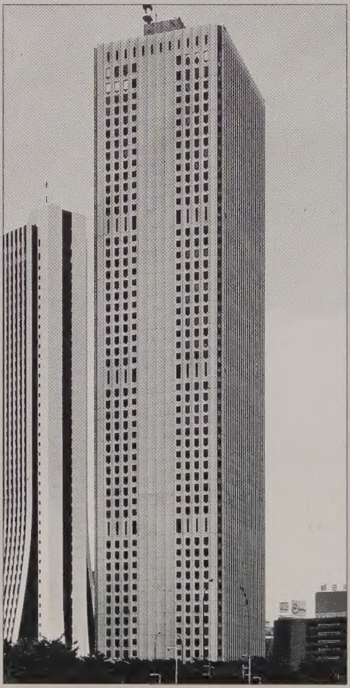
YOKOGAWA has a dedicated sales and service network worldwide, expanded over forty countries. Also, we have manufacturing facilities and service centers in the USA, Europe, Singapore and Brazil. We stand ready and willing to assist in satisfying your measuring and testing requirements.

**Corporate Headquarters and Main Factory in the Suburbs of Tokyo**



**YOKOGAWA CORPORATION OF AMERICA**

**YOKOGAWA ELECTRIC ASIA**



**Tokyo Sales Office in the Shinjuku Center Bldg., Tokyo**

**YOKOGAWA EUROPE**

**YOKOGAWA ELETRICA DO BRASIL**

# Product Groups

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**For further information**

This catalog gives only the basic performance specifications of selected products in our line of electrical measuring and recording instruments. Further details are available from our sales/service offices and representatives, or from International Sales Department.

**Dimensions and weight**

The dimensions of all instruments shown herein are given in approximate values. Handles, rubber legs and the like are not, in principle, included in the dimensions and weight.

**Interface bus**

Products with ▨ mark incorporates a communication function which supports the system use. Available communication interface is shown inside the ▨ mark.

**Accessories and spares**

All of the accessories and spares are not included in this catalog. Please ask for further details if necessary.

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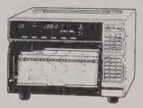
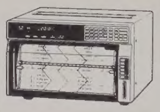
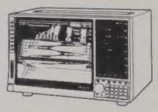
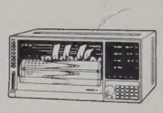
All descriptions in this catalog are subject to change without notice.

## INTELLIGENT RECORDERS SELECTION GUIDE

| | |  |  |  |  | |
|---|---|---|---|---|---|---|
| **Model** | | **HR1300** | **HR2300** | **LR8100** | **LR4100** | **LR4200** |
| **Writing System** | | Wire-dot printer | | Disposable felt-tip pens (analog), and wire-dot printer (digital) | | |
| **Effective Recording Span** | | 150 mm (6″) | 250 mm (10″) | 250 mm (10″) | 250 mm (10″) | 250 mm (10″) |
| **No. of Inputs** | | 10, 20 | 20, 30 | 4, 6, 8 | 1, 2, 3, 4 | 1, 2, 3, 4 |
| **Input Signal (Range)** | **DC V** | 20 mV to 50 V | | 0.1 mV to 200 V | | |
| | **TC** | 12 types | | 12 types | | |
| | **RTD** | Pt100, JPt100, Pt50, Ni100, Ni120, Cu10, J263＊B | | Pt100, JPt100, Pt50, Ni100, J263＊B | | |
| | **Others** | Contact status, AC V, AC A | | – | – | – |
| **Display** | **Digital** | VFD (DC V: 4-1/2 digits) | | VFD (DC V: 4-1/2 digits) | | |
| | **Analog** | Bar graph | | Bar graph | | |
| **Printout** | **Analog & Digital Data** | ○ | ○ | ○ | ○ (LR4110) | ○ (LR4210) |
| | **Scale Printout** | ○ | ○ | ○ | ○ (LR4110) | ○ (LR4210) |
| | **Alarm** | ○ | ○ | ○ | ○ (LR4110) | ○ (LR4210) |
| | **Zone** | ○ | ○ | ○ | ○ | ○ |
| | **Partially Expanded Scale** | ○ | ○ | ○ | ○ | ○ |
| | **Auto Span Shift** | – | – | ○ | ○ | ○ |
| **Scan Cycle Time** | | 2 s/20 points | 1 s/30 points | 135 Hz (7.4 ms) | | |
| **Print Cycle Time** | | 2 s/50 points | 2 s/60 points | Continuous | | |
| **Max. Pen Speed** | | – | – | 1,600 mm/s | | |
| **Pen Offset Compensation (Pen Model Only)** | | – | – | ○ | ○ | ○ |
| **Chart Speed** | | 1 to 1,500 mm/h | | 10 to 1,200 mm/min & mm/h | | |
| **Mathematical Functions** | **Linear Scaling, ΔT** | ○ | ○ | ○ | ○ | ○ |
| | **Square Root** | ○ | ○ | ○ | ○ | ○ |
| | +, −, ×, ÷ | ○ | ○ | ○ | ○ | ○ |
| | **Statistical** | ○ | ○ | – | – | – |
| | **Other Computation** | Absolute value, logarithm, exponential, relational | | Absolute value, logarithm, exponential | | |
| **Alarm** | **No. of Alarm Set Levels/Channel** | 6 | 6 | 2 | 2 | 2 |
| | **Alarm Outputs (Optional)** | 2 points | 72 points (internal: 12 points) | 8 points | 4 points | 4 points |
| | **Alarm Type** | H, L, ΔH, ΔL, RH, RL | | H, L, ΔH, ΔL | | |
| **Interface** | | GPIB, RS-232-C | | GPIB, RS-232-C | | |
| **Power Requirements** | | AC, DC | | AC, DC | | AC |

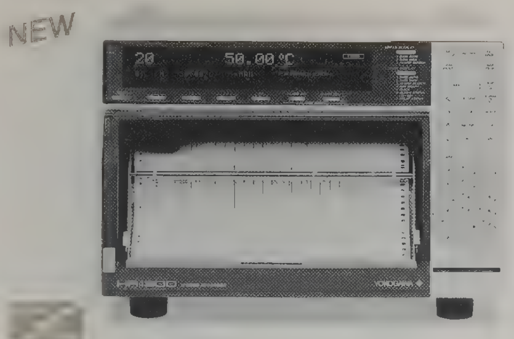
## X-Y RECORDERS

| **Model** | | **3023, 3024** | **3025** | **3022** | **3036** |
|---|---|---|---|---|---|
| **Writing Area** | | A3 size (381×254 mm) | A4 size (254×180 mm) | A4 size (250×180 mm) | (250×250 mm) |
| **No. of Pens** | | 1, 2 | 1, 2 | 1 | 1, 2 |
| **Input Ranges** | | 50 μV to 5 V/cm | 50 μV to 5 V/cm | 0.5 mV to 2.5 V/cm | 5 μV to 5 V/cm |
| **Accuracy** | | ±0.2% | ±0.25% | ±0.25% | ±0.25% |
| **Input Impedance** | | 1 MΩ | 1 MΩ | 1 MΩ | 1 MΩ |
| **Slewing Speed** | **X** | 2,000 mm/s | 2,000 mm/s | 300 mm/s | 500 mm/s |
| | **Y** | 2,200 mm/s | 2,200 mm/s | 500 mm/s | 500 mm/s |
| **Paper Holddown** | | Electrostatic | Electrostatic | Mechanical | Electrostatic |
| **Time Base** | | 0.25 to 50 s/cm & min/cm | 0.25 to 50 s/cm & min/cm | 0.25 to 10 s/cm & min/cm | 0.25 to 10 s/cm |
| **Chart Drive Unit** | | ○ | ○ | – | ○ |

Note: ○... Available

# HYBRID RECORDERS

## HR1300 Portable Hybrid Recorder 3750



**3750** 221×338×341.5 mm 9.7 kg

The HR1300 is a high-speed portable hybrid recorder with a recording span of 150 mm (5-7/8″) with ten color recording. It uses a YOKOGAWA-original high breakdown voltage solid state relay, which offers high-speed scanning of 20 points/2 s and high-speed recording of 50 points/2 s. It is a lightweight design (approx. 10 kg, 21 lbs) and has an optional feature of DC power source, making it ideal for many fields of applications such as in laboratories and on vehicles.

**Versatile functions within a portable package**
The HR1300 incorporates many outstanding functions, weighs approx. 10 kg (21 lbs), and is DC powered.

**High-speed scanning: 20 points/2 s**
Input data is scanned every 2 seconds, and transferred to IC memory card or to a supervisory computer via a GPIB or RS-232-C interface.

**High-speed recording: 50 points/2 s**
In two seconds, 20 input points in addition to another 30 points for computed data, digital inputs and IC memory card data can be recorded in analog form.

**Ten-color recording**
Color can easily be designated for each channel.

**IC memory card**
Large memory capacity of 512k bytes. UP to 47 files of both setting and measured data can be stored.

**Computer friendly** (optional)
GPIB or RS-232-C interface are available.

**Multiple computing functions** (optional)
It features the following computing functions: +, −, ×, ÷, SQR, absolute value, common logarithm, exponential computation, relational computation, TLOG and CLOG.

**Universal input types**
DC V, TC, RTD and contact status.

**High accuracy:** ±(0.05% of rdg + 2 digits) on 2 V range.

**Highly visible vacuum fluorescent display** (**7×5 dots, 48 characters**)

**Wide voltage range power supply**
90 to 250 V AC and DC power source (10 to 32 V DC: optional).

**AC input** (voltage & current: optional)

**Number of Inputs:** Up to 10 or 20 points.
**Input Types, Ranges:**
DC V: 20/60/200 mV/2/6/20/50 V,
TC: R/S/B/K/E/J/T/L/U/N/W/KPvsAu7Fe.
RTD: Pt100/JPt100 Pt50/Ni100/Ni120/Cu10 J263∗B.
(Any of DC V, TC, RTD, and DI inputs can be selected for each input point.)
**Recording Accuracy** (**Analog trend**): ±0.2% of span (not including measurement accuracy).
**Scan Cycle Time:** 2 to 60 s selectable (2, 3, 4, 5, 6, 10, 12, 15, 20, 30, 60 s).
**Printing Technique:** Raster scan using a wire-dot printer and a 10-color ribbon.
**Effective Recording Span:** 150 mm (6″) (analog data).
**Chart:** Z-fold chart (230 mm ×20 m; 9″×66′) with calibrated width of 150 mm.
**Recording Colors:** Analog data (TREND mode)...10 colors (black, blue, navy blue, green, yellowish green, purplish red, brown, orange, red and purple), color can be specified for every channel.
**Printout Format:** Analog trend/analog trend+digital/logging.
**Chart Speeds:** 1 to 1,500 mm/h.
**Recording Cycle Time:** Minimum 2 s.
**Printout Functions:** Engineering units, tag number, alarm, scale markings, program list, manual printout, message printing & header printing.
**Type of Display:** Vacuum fluorescent display (5×7 dot matrix, blue), 2 lines (upper display...20 characters, larger size, lower display...28 characters, smaller size).
**Computing Functions** (**Standard**): Scaling, differential calculation (ΔT) & moving average.
**IC Memory Card:** Setting data, measured data, communication input data and programmed parameter can be stored on a memory card (accessory)
**Number of Alarm Set Levels:** Up to 6 levels/channel.
**Alarm Types:** High (H), low(L), high-rate of change (RH), low-rate of change (RL), delta high (ΔH), and delta low(ΔL)
Rate of change (time interval): Measurement cycle×(1 to 15).
**Alarm Outputs** (**Optional**): Up to 2 points (internal)
**Dimensions:** Approx. 221(H)×338(W)×314.5 (D) mm, (8-11/16×13-5/16×13-7/16″). depth with screw input terminal block: 360 mm (14-3/16″).
**Weight:** Approx. 9.7 kg (21.3 lbs).
**Power Supply:** 90 to 250 V AC, 50 and 60 Hz (must be specified).
**Power Consumption:** Approx. 80 VA.
**Optional Features:** GPIB interface, RS-232-C interface, computation, remote control, internal alarm output, DC power source, user's linearization & remote RJC and AC input

### AVAILABLE MODELS

| Model | Suffix Codes | | | Description |
|---|---|---|---|---|
| **3750** | | | | Portable Hybrid Recorder **HR1300** |
| Relay Types | **12** | | | 10 points/2 s (high breakdown voltage solid state relay) |
| | **22** | | | 20 points/2 s (high breakdown voltage solid state relay) |
| Power Requirements | | **-0** | | 90 to 250 V AC |
| Frequency | | | **1** | 50 Hz |
| | | | **2** | 60 Hz |
| Optional Feature | | | /□ | Refer to OPTIONAL FEATURES |

### OPTIONAL FEATURES

| Option Code | Description |
|---|---|
| **/GP-IB** | GPIB interface |
| **/RS232C** | RS-232-C interface |
| **/MATH** | Mathematical functions |
| **/REM** | Remote controls |
| **/AK-02** | Alarms (internal, 2 points) |
| **/SIT** | Screw input terminal block |
| **/DF** | °F display |
| **/DC** | DC power source |
| **/ULN** | User's linearization and remote RJC |
| **/AC2** | AC input (voltage 1 input, current 1 point) |
| **/AC6** | AC input (voltage 3 inputs, current 3 points) |

Both **/GP-IB** and **/RS232C** interface cannot be used in a single instrument
Both AC input **/AC2** and **/AC6** cannot be used in a single instrument

### OPTIONAL ACCESSORIES

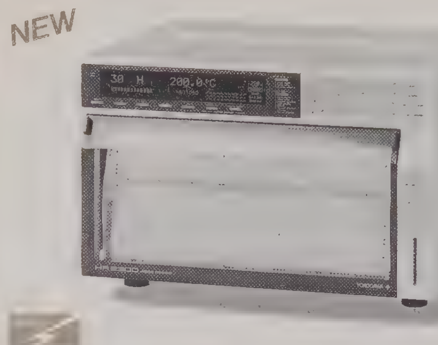
| Name | Code | Description | Order Q'ty |
|---|---|---|---|
| IC memory card | **378903** | Setting & measured data 64K bytes | 1 unit (1 pc./unit) |
| IC memory card | **378904** | Setting & measured data, 256K bytes | |
| IC memory card | **378905** | Setting & measured data 512K bytes | |
| Clamped input terminal block* | **379801** | 10 points | 1 unit (1 pc./unit) |
| Screw input terminal block* | **379802** | 10 points | |
| Shunt resistor (for clamped input terminal block) | **438920** | 250 Ω ± 0.1% | 1 unit (1 pc./unit) |
| | **438921** | 100 Ω ± 0.1% | |
| | **438922** | 10 Ω ± 0.1% | |
| Shunt resistor (for screw input terminal block) | **415920** | 250 Ω ± 0.1% | |
| | **415921** | 100 Ω ± 0.1% | |
| | **415922** | 10 Ω ± 0.1% | |
| Rack mounting kit (JIS) | **379811** | – | 1 unit (1 pc./unit) |
| Rack mounting kit (ANSI) | **379813** | – | |

*379801 cannot be used when **/SIT** option is specified
**379802 /SIT** option must be specified

### SPARES

| Name | Part No. | Description | Order Q'ty |
|---|---|---|---|
| Ribbon cassette | **B9627AZ** | [illegible] | [illegible] |
| Z-fold chart | **B9855AY** | 20 m 10 mm div on time axis | [illegible] |

# HR2300 Hybrid Recorder 3760



**3760** 266×438×415 mm 15 kg

The HR2300 is a high-speed Hybrid Recorder with an effective recording span of 250 mm(10″) which can scan 30 points in one second, and record 60 points in two seconds through the use of a YOKOGAWA-original high breakdown voltage solid state relay. The HR2300 is the most sophisticated hybrid recorder because of its simple operation and multiple functions which include recording in ten colors, data saving and loading from an IC memory card, a variety of alarms etc.

This interactive menu-driven recorder with its powerful analytical functions, is ideal for many fields of R & D and laboratory applications.

**High-speed scanning: 30 points/s (high breakdown voltage solid state relay)**
Retained analysis is possible because digital data which is sampled every second can be transferred to IC memory card or to a host computer.

**High-speed recording: 60 points/2 s**
In two seconds, 30 input points – in addition to another 30 points for computed data, digital inputs and IC memory card data – can be recorded in analog form.

**Ten-color recording**
Color can easily designated for each channel.

**Multiple computing functions (optional)**
It features the following computing functions: +, −, ×, ÷, SQR, absolute value, common logarithm, exponential computation, relational computation, TLOG and CLOG.

**IC memory card**
Both setting and measured data can be stored in large memory capacity of 512K bytes.

**Universal input types:**
DC Voltages, TC, RTD and contact status.

**DC power source (optional)**
10 to 32 V DC power source.

**High accuracy:** ±0.05% of rdg ± 2 digits (2 V range).

**Vacuum fluorescent large-scaled display**
5×7 dot matrix. 48 character.

**GPIB or RS-232-C interface (optional)**

**AC input (voltage & current: optional)**

---

**Number of Inputs:** Up to 20 or 30 points.

**Input Types, Ranges:**
DC V: 20/60/200 mV/2/6/20/50 V.
TC: R/S/B/K/E/J/T/L/U/N/W/KPvsAu7Fe.
RTD:Pt100/JPt100/Pt50/Ni100/Ni120/Cu10/J263∗B.
Contact Status (input signal: contact status or DC V).
(Any of DC V, TC, RTD and DI inputs can be selected for each input point.)

**Recording Accuracy (Analog Trend):** ±0.1% of span (not including measurement accuracy)

**Scan Cycle Time:** 1 to 60 s selectable (1, 2, 3, 4, 5, 6, 10, 12, 15, 20, 30, 60 s)

**Printing Technique:** Raster scan using a wire-dot printer and a 10 color ribbon

**Effective Recording Span:** 250 mm (10″) (analog data)

**Chart:** Z-fold chart (342.5 mm×30 m, 13.5″× 98′) with calibrated width of 250 mm (10″).

**Recording Colors:** Analog data (TREND mode)... 10 colors (purple, red, green, blue, brown, black, navy blue, yellowish green, purplish red, orange), color can be specified for every channel.

**Printout Format:** Trend and/or logging.

**Chart Speeds:** 1 to 1,500 mm/h.

**Recording Cycle Time:** Minimum 2 s.

**Printout Functions:** Engineering units, tag number, alarm, scale markings, program list, manual printout, message printing, and header printing.

**Type of Display:** Vacuum fluorescent large-scaled display (5×7 dot matrix, blue), 2 lines (upper display... 20 characters, larger size; lower display... 28 characters, smaller size).

**Computing Functions:** Scaling, differential calculation (ΔT) and moving average.

**IC Memory Card:** Setting data, measured data, communication input data and programmed parameters can be stored on a memory card.

**Number of Alarm Set Levels:** Up to 6 levels/channel.

**Alarm Types:** High (H), low (L), high-rate of change (RH), low-rate of change (RL), delta high (ΔH), and delta low (ΔL).

**Alarm Outputs (Optional):** Up to 12 points... internal, up to 60 points...separate case(s)

**Power Requirements:** 90 to 250 V AC (wide range power supply), 50 and 60 Hz (must be specified).

**Power Consumption:** Approx. 80 VA (230V).

## AVAILABLE MODELS

| Model | | Suffix Codes | | | Description |
|---|---|---|---|---|---|
| 3760 | | | | | Hybrid recorder (**HR2300**) |
| No of Inputs & Relay Types | 20 | | | | 20 points/2 s,(electromagnetic relay) |
| | 21 | | | | 20 points/1 s,(high breakdown voltage solid state relay) |
| | 22 | | | | 20 points/2 s,(high breakdown voltage solid state relay) |
| | 30 | | | | 30 points/2 s,(electromagnetic relay) |
| | 31 | | | | 30 points/1 s,(high breakdown voltage solid state relay) |
| | 32 | | | | 30 points/2 s,(high breakdown voltage solid state relay) |
| Power Requirements | | -0 | | | 90 to 250 V AC |
| Frequency | | | -1 | | 50 Hz |
| | | | -2 | | 60 Hz |
| Optional Features | | | | /☐ | Refer to Optional Features |

## OPTIONAL FEATURES

| Option Code | Description |
|---|---|
| /GP-IB | GPIB interface |
| /RS232C | RS-232-C interface |
| /MATH | Mathematical functions |
| /REM | Remote controls |
| /AK-02 | Alarms (internal, 2 points) |
| /AK-12 | Alarms (internal, 12 points) |
| /SIT | Screw input terminal block |
| /EAI | Interface for external alarm relay (for **379101** and **379102** only) |
| /LMP | Internal illumination |
| /DF | °F display |
| /DC | DC power source |
| /RPT | Hourly, daily or monthly reports |
| /ULN | User's linearization and remote RJC |
| /AC2 | AC input<br>(AC voltage 1 point, AC current 1 point) |
| /AC6 | AC input<br>(AC voltage 3 points, AC current 3 points) |

## OPTIONAL ACCESSORIES

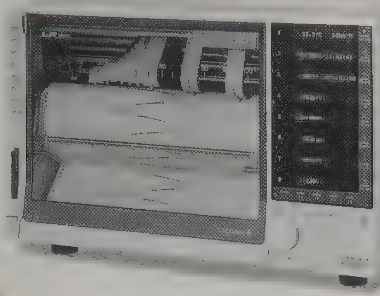
| Name | Code | Description | Order Q'ty |
|---|---|---|---|
| IC memory card | 378903 | Setting & measured data, 64K bytes | 1 pc |
| IC memory card | 378904 | Setting & measured data, 256K bytes | |
| IC memory card | 378905 | Setting & measured data, 512K bytes | |
| External alarm output relay | 379101 | 30 points | 1 pc |
| External alarm output relay | 379102 | 60 points | |
| Rack mounting kit | 379812 | JIS | 1 pc. |
| | 379814 | ANSI/EIA | |
| Clamped input terminal block | 379801 | 10 points | |
| Screw input terminal block | 379802 | 10 points | 1 pc. |
| Shunt resistor (For clamped input terminal block) | 438920 | 250 Ω±0.1% | |
| | 438921 | 100 Ω±0.1% | |
| | 438922 | 10 Ω±0.1% | |
| Shunt resistor (For screw input terminal block) | 415920 | 250 Ω±0.1% | |
| | 415921 | 100 Ω±0.1% | |
| | 415922 | 10 Ω±0.1% | |
| Cable for external alarm | B9857ZD | 1 m | 1 pc |
| | B9857ZE | 2 m | |
| | B9857ZF | 5 m | |
| | B9857ZG | 10 m | |

## SPARES

| Name | Part No. | Description | Order Q'ty |
|---|---|---|---|
| Ten-color ink ribbon | B9627AZ | Ten-color ink ribbon | [illegible] |
| Z-fold chart | B9627RY | 30 m, 10 mm div. on time axis | 6 units<br>(1 chart/unit) |
| Z-fold chart | B9627AY | 30 m, 25 mm div. on time axis | |

# LR8100 Recorders 3701

NEW



**37018**□ 266×438×310 mm 18 kg
(8-channel model)

The LR8100 is a new intelligent 250 mm pen recorder lineup including 4-, 6- and 8-channel models. All models handle a wide range of input types—DC voltage, 12 types of thermocouples and four types of resistance bulbs for each channel. In addition to clear, highly-readable color traces, LR8100 also provides versatile alphanumeric printout functions such as digital data printout, scale markings, alarms and message. Operation of LR8100 is very simple using front-panel keys, prompt type menus, and a rotating knob.

**4-, 6-, 8-channel models**

**A wide range of input types**

A single instrument accepts the inputs of DC V, 12 types of TC's (ANSI, DIN, JIS) and 4 types of RTD's.

**New recording mechanism for long-term clear, distinct color traces**

New recording system features a chart length of 30 m (98 ft), and total pen trace length of about 1,500 m (4,900 ft) without blotting and smudge.

**High pen speed—1,600 mm/s (5.2 ft/s) max.**

**Versatile alphanumeric printout modes**

Full selection of alphanumeric printout modes include measured data, scale markings, alarms, message, manual, program list, and more.

**Zone (RECORD AREA ADJ) and partially expanded-scale recording, and AUTO SPAN SHIFT mode**

Highly diverse recording of Zone, partially expanded-scale and AUTO SPAN SHIFT are selectable for each channel. On AUTO SPAN SHIFT mode, recording span is automatically shifted to ±50%, when the input exceeds the measuring span and recording continues.

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**Drive System:** Automatic null-balancing digital servo mechanism with brushless DC servomotor.

**Input Types & Measuring Ranges:** DC V..10 mV to 200 V F.S., 1 mV to 200 V F.S., or 0.1 mV to 200 V F.S.
TC (ANSI, DIN, JIS)...Type R, S, B, K, E, J, T, N, W, L (DIN), U (DIN).
TC (NBS)...KPvsAu7Fe (4 to 280K).
RTD (DIN, JIS or SAMA)...Pt100 (1 mA), JPt100 (1 mA), Pt50 (1 mA), Ni100.
RTD (YOKOGAWA)...J263∗B (2 to 300K; Pt-Co).

**Accuracy:** DC V..±(0.05% of rdg+0.03% of range+0.5 μV).
TC...±(0.05% of rdg+0.5°C) for K, E, J, T, L, U and KPvsAu7Fe.

**Pen Offset Compensation (Standard):** Average, max./min. recording selectable (with compensation ON/OFF switch).

**Input Impedance:** Approx 1 MΩ (DC V & TC)

**Writing & Printing System:** Ink writing using disposable felt-tip pen cartridges (analog data), and wire-dot printer using ribbon cassette (digital data).

**Effective Recording Span:** 250 mm(10")(analog data).

**Number of Channels:** 4, 6 or 8.

**Recording Colors:**

| 1st | 2nd | 3rd | 4th | 5th | 6th | 7th | 8th |
|---|---|---|---|---|---|---|---|
| Red | Green | Blue | Brown | Black | Purple | Orange | Violet |

**Recording Accuracy:** Measurement accuracy+±0.2% of effective recording span (including non-linearity, deadband and error between ranges).

**Maximum Pen Speed:** Approx. 1,600 mm/s.

**Chart:** Z-fold chart (270 mm×30 m, 10-1/2"×98').

**Chart Speeds:** 10 to 1,200 mm/min & mm/h (1 mm steps), and 0.5 to 45.0 inch/min & inch/h (0.1 inch steps).

**Type of Display:** Vacuum fluorescent display (5×7 dot matrix, blue), 20 characters for each channel.

**Display Modes:** Digital data display, bar graph display, range data display.

**Number of Alarm Set Levels:** Up to 2 levels/channel.

**Alarm Outputs (Optional):** Up to 8 points (internal), contact rating...24 V AC 1 A.

**Standard Computing Functions:** Scaling (ranges..−22,000 to+22,000), and ΔT

**Optional Mathematical Functions:** +, −, ×, ÷, square root, absolute value, logarithm, exponential function (up to 8 channels).

**Standard IC Memory Card:** For storing setting data (memory capacity of 8K bytes).

**Power Requirements:** 90 to 250 V AC, for both 50 and 60 Hz.

**Power Consumption:** 4-channel model...130 VA max., 60 VA balanced, 6-channel model...160 VA max., 70 VA balanced, 8-channel model...190 VA max., 80 VA balanced.

**Weight (Approx):** 4-channel model...16 kg (35.3 lbs), 6-channel model...17.5 kg (38.6 lbs), 8-channel model...18 kg (39.7 lbs)

## ▨ AVAILABLE MODELS

| Model | | Suffix Codes | Description |
|---|---|---|---|
| **3701** | ······ | ··············· | LR8100 Recorder |
| No of channels | **4** ··· | ··············· | 4-pen model |
| | **6** ··· | ··············· | 6-pen model |
| | **8** ··· | ··············· | 8-pen model |
| Input types & max sensitivity | **1** | ··············· | 10 mV F.S.(DC V, TC) |
| | **2** | ··············· | 1 mV F.S.(DC V, TC) |
| | **3** | ··············· | 0.1 mV F.S.(DC V, TC) |
| | **4** | ··············· | 10 mV F.S.(DC V, TC, RTD) |
| | **5** | ··············· | 1 mV F.S.(DC V, TC, RTD) |
| | **6** | ··············· | 0.1 mV F.S.(DC V, TC, RTD) |
| Version up | | **-B** ········· | — |
| Power requirement | | **-0** ········· | 90 to 250 V AC |
| Power cord | | **/B** ······ | JIS standard |
| | | **/D** ······ | UL standard |
| | | **/F** ······ | VDE standard |
| | | **/G** ······ | SAA standard |
| Optional features | | **/GP-IB** | GPIB interface |
| | | **RS232C** | RS-232-C interface |
| | | **/MATH** | Mathematical functions |
| | | **/AK-08** | Alarms (internal, 8 points) |
| | | **/REM** | Remote controls |
| | | **/DC** | DC power source |
| | | **/DF** | °F display |

## ▨ OPTIONAL ACCESSORIES

| Name | Part No. | Order Q'ty |
|---|---|---|
| Rack adapter (ANSI & JIS) | **378981** | 1 unit (1 pc./unit) |
| IC memory card (setting & measured data), 256K bytes | **378904** | 1 set |

## ▨ SPARES

| Name | | Part No. | Order Q'ty |
|---|---|---|---|
| Ribbon cassette | | **B9585SH** | 1 unit (1 pc./unit) |
| Z fold chart (270 mm × 30 m) | | **B9585AH** | 10 units (1 chart/unit) |
| *Disposable felt-tip pen cartridge | 1st channel (red) | **B9586□A** | 1 unit (3 pcs./unit) |
| | 2nd channel (green) | **B9586□B** | |
| | 3rd channel (blue) | **B9586□C** | |
| | 4th channel (brown) | **B9586□D** | |
| | 5th channel (black) | **B9586□E** | |
| | 6th channel (purple) | **B9586□F** | |
| | 7th channel (orange) | **B9586□G** | |
| | 8th channel (violet) | **B9586□H** | |
| | 1st to 4th channels | **B9586□R** | 1 unit (1 pc. each/unit) |
| | 1st to 6th channels | **B9586□S** | |
| | 1st to 8th channels | **B9586□T** | |
| Memory card (setting data) 8K bytes | | **378901** | 1 unit (1 pc./unit) |
| Lithium battery (for mainframe) | | **B9588ZB** | |
| Lithium battery (for **378901**) | | **B9586JU** | 2 units (1 pc./unit) |
| Lithium battery (for **378904**) | | **B9586JV** | |
| Dust cover | | **B9585AY** | 1 pc |
| Measurement leads (1 m) | | **B9409JA** | 1 set |

***Note:** Specify **X**, **Y** or **Z** in □
**Y** Standard (pen speed of lower than approx. 800 mm/s)
**Z** High speed (pen speed of higher than approx. 800 mm/s)
**X** Low speed (chart speed of lower than approx. 100 mm/h)

# LR SERIES RECORDERS

## LR4100 Recorders 3711 & 3712

**37114**□ 199×438×323 mm 14 kg.

The LR4100 is a vertical 1- to 4-pen recorder with 250 mm effective recording span. The LR4100 has versatile functions such as mixed input types of DC V, 12 types of TC's and 4 types of RTD's for each channel, versatile digital printout functions (LR4110), three display modes, highly-readable color trace, IC memory card and convenient optional features (DC power source, GPIB or RS-232-C interface etc). In addition to these many functions, easy operation, similar to conventional recorders, is characteristic of the LR4100.

**A wide range of input types**

A single instrument accepts the inputs of DC V, 12 types of TC's (ANSI, DIN, JIS), and 4 types of RTD's.

**Versatile alphanumeric printout modes (LR4110)**

Full selection of alphanumeric printout modes include measured data, date & time, scale markings, alarms, message, manual, program list and more.

**A choice of 3 display modes**

Measured data, bar graph, or range data display.

**Zone recording**

Recording position can be set for each pen in % basis.

**Partially expanded-scale recording**

Any portion within full scale can be expanded or reduced for each pen.

**AUTO span shift**

On AUTO SPAN SHIFT mode, recording span is automatically shifted to ±50%, and recording continues when the input exceeds the measuring span.

**GPIB or RS-232-C interface (Optional)**

**Drive System:** Automatic null-balancing digital servo mechanism with brushless DC servomotor

**Input Types & Measuring Ranges:** DC V..10 mV to 200 V F.S., 1 mV to 200 V F.S., or 0.1 mV to 200 V F.S.

TC (ANSI, DIN, JIS)...Type R, S, B, K, E, J, T, N, W, L (DIN), U (DIN).

TC (NBS)...KPvsAu7Fe (4 to 280K).

RTD...Pt100 (1 mA), JPt100(1 mA), Pt50 (1 mA), Ni100(1 mA).

RTD (YOKOGAWA)...J263∗B (2 to 300K; Pt-Co).

**Accuracy:** DC V...±(0.05% of rdg + 0.03% of range + 0.5 μV).

TC...±(0.05% of rdg + 0.5°C) for K, E, J, T, L, U and KPvsAu7Fe.

**Pen Offset Compensation (Standard):** Average, max./min. recording selectable (with compensation ON/OFF switch).

**Input Impedance:** Approx. 1 MΩ (DC V & TC).

**Writing & Printing System:** Ink writing using disposable felt-tip pen cartridges (analog data), and wire-dot printer using ribbon cassette (digital data).

**Effective Recording Span:** 250 mm (analog data).

**Number of Channels:** 1, 2, 3, or 4.

**Recording Colors:**

| 1st | 2nd | 3rd | 4th |
|---|---|---|---|
| Red | Green | Blue | Brown |

**Recording Accuracy:** Measurement accuracy+±0.2% of effective recording span (including non-linearity, deadband and error between ranges).

**Maximum Pen Speed:** Approx. 1,600 mm/s.

**Chart:** Z- fold chart (270 mm×20 m).

**Chart Speeds:** 10 to 1,200 mm/min & mm/h (1 mm steps), and 0.5 to 45.0 inch/min & inch /h (0.1 inch steps).

**Type of Display:** Vacuum fluorescent display (5×7 dot matrix, blue), 20 characters for each channel.

**Display Modes:** Digital data display, bar graph display, range data display.

**Number of Alarm Set Levels:** Up to 2 levels/channel.

**Alarm Outputs (Optional):** Up to 8 points (internal, contact rating...24 V AC 1 A).

**Standard Computing Functions:** Scaling (range..-22000 to +22000), and ΔT.

**Optional Mathematical Functions:** +, −, ×, ÷, square root, absolute value, logarithm, exponential function (up to 4 channels).

**Standard Memory Card:** For storing setting data (memory capacity of 8K bytes).

**Power Requirements:** 90 to 250 V AC, for both 50 and 60 Hz.

**Power Consumption:** 1-channel model...85 VA max., 55 VA balanced, 2-channel model... 100 VA max., 60 VA balanced, 3-channel model...115 VA max., 65 VA balanced, 4-channel model...130 VA max., 70 VA balanced.

**Weight (Approx):**

| Model | 1-channel | 2-channel | 3-channel | 4-channel |
|---|---|---|---|---|
| **LR4110** | 12.5 kg (27.1 lbs) | 13 kg (28.7 lbs) | 13.5 kg (29.8 lbs) | 14 kg (30.9 lbs) |
| **LR4120** | 11.5 kg (25.4 lbs) | 12 kg (26.5 lbs) | 12.5 kg (27.6 lbs) | 13 kg (28.7 lbs) |

### AVAILABLE MODELS

| Model | | Suffix Codes | Description |
|---|---|---|---|
| **3711** | | | **LR4110** Recorder (with printer & electrical pen lift) |
| **3712** | | | **LR4120** Recorder (without printer & manual pen lift) |
| No. of Channels | **1** | | 1-pen model |
| | **2** | | 2-pen model |
| | **3** | | 3-pen model |
| | **4** | | 4-pen model |
| Input types & max. sensitivity | **1** | | 10 mV F.S. (DC V, TC) |
| | **2** | | 1 mV F.S. (DC V, TC) |
| | **3** | | 0.1 mV F.S. (DC V, TC) |
| | **4** | | 10 mV F.S. (DC V, TC, RTD) |
| | **5** | | 1 mV F.S. (DC V,TC, RTD) |
| | **6** | | 0.1 mV F.S. (DC V, TC, RTD) |
| Version up | | **-B** | — |
| Power requirement | | **-0** | 90 to 250 V AC |
| Power cord | | **/B** | JIS standard |
| | | **/D** | UL standard |
| | | **/F** | VDE standard |
| | | **/G** | SAA standard |
| Optional features | | **/GP-IB** | GPIB interface |
| | | **RS232C** | RS-232-C interface |
| | | **MATH** | Mathematical functions |
| | | **/AK-04** | Alarms (internal, 4 points) |
| | | **/REM** | Remote controls |
| | | **/DC** | DC power source |
| | | **/DF** | °F display |

### OPTIONAL ACCESSORIES

| Name | Part No. | Order Q'ty |
|---|---|---|
| Rack mounting kit (ANSI & JIS) | **378982** | 1 unit (1 pc./unit) |
| IC memory card (setting & measured data), 256K bytes | **378904** | 1 set |

### SPARES

| Name | | Part No. | Order Q'ty |
|---|---|---|---|
| Ribbon cassette | | **B9585SH** | 1 unit (1 pc./unit) |
| Z-fold chart (270 mm×20 m) | | **B9619AH** | 10 units (1 pc./unit) |
| •Disposable felt-tip pen cartridge | 1st channel (red) | **B9586□A** | 1 unit (3 pcs./unit) |
| | 2nd channel (green) | **B9586□B** | |
| | 3rd channel (blue) | **B9586□C** | |
| | 4th channel (brown) | **B9586□D** | |
| | 1st to 4th channel | **B9586□R** | 1 unit (1 pc./unit) |
| Memory card (setting data), 8K bytes | | **378901** | 1 unit (1 pc./unit) |
| Dust cover | | **B9619AV** | |
| Lithium battery (for mainframe) | | **B9588ZB** | |
| Lithium battery (for **378901**) | | **B9586JU** | 2 units (1 pc./unit) |
| Lithium battery (for **378904**) | | **B9586JV** | |
| Measurement leads (1 m) | | **B9409JA** | 1 set |

• **Note:** Specify **X**, **Y**, or **Z** in □

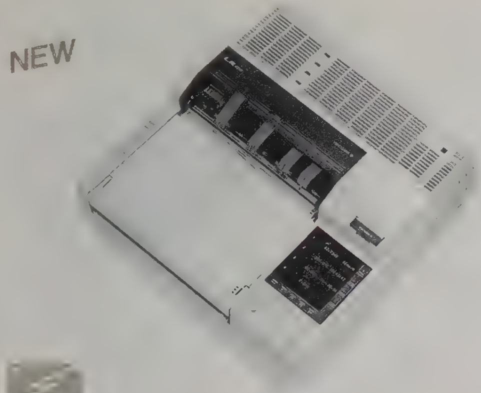
**Y** Standard (pen speed of lower than approx. 800 mm/s)

**Z** High speed (pen speed of higher than aprox. 800 mm/s)

**X** Low speed (chart speed of lower than approx. 100 mm/h)

# LR4200 Recorders 3721 & 3722

NEW



**37214**☐ 185×448×445 mm 14 kg

The 1- to 4-pen flatbed LR4200 is part of the LR Series. LR4200 has versatile functions such as mixed input types of DC V, 12 types of TC's and 4 types of RTD's for each channel, versatile digital printout functions (LR4210), three display modes, and highly-readable color trace, IC memory card, GPIB or RS-232-C interface. In addition to these multi-functions, easy operation similar to conventional recorders is also an important feature of the LR4200.

**A wide range of input types**
A single instrument accepts the inputs of DC V, 12 types of TC's (ANSI, DIN, JIS), and 4 types of RTD's.

**Versatile alphanumeric printout modes (LR4210)**
Full selection of alphanumeric printout modes include measured data, date & time, scale markings, alarms, message, manual, program list and more.

**A choice of 3 display modes**
Measured data, bar graph, or range data display.

**Zone recording**
Recording position can be set for each pen in % basis.

**Partially expanded-scale recording**
Any portion within full scale can be expanded or reduced for each pen

**AUTO span shift**
In AUTO SPAN SHIFT mode, recording span is automatically shifted to ±50%, and recording continues when the input exceeds the measuring span.

**Standard or optional IC memory card**
Standard IC memory card is used for storing setting data while optional IC memory card is used for storing measured and panel setting data with memory capacity of 256K bytes.

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**Drive System:** Automatic null-balancing digital servo mechanism with brushless DC servomotor

**Input Types & Measuring Ranges:** DC V..10 mV to 200 V F.S., 1 mV to 200 V F.S., or 0.1 mV to 200 V F.S,
TC (ANSI, DIN, JIS)...Type R, S, B, K, E, J, T, N, W, L (DIN), U (DIN),
TC (NBS)...KPvsAu7Fe (4 to 280K),
RTD (DIN, JIS or SAMA)...Pt100(1 mA), JPt 100 (1 mA), Pt 50(1 mA), Ni100,
RTD.. YOKOGAWA...J263∗B (2 to 300 K, Pt-Co).
Pt100: JIS C1604-1989, JIS C1606-1989, DIN IEC 751, IEC 751,
JPt100: JIS C1604-1989, JIS C1606-1989,
Pt50: JIS C1604-1981, JIS C1606-1986,
Ni100: DIN, SAMA.

**Measurement Accuracy:** DC V...±(0.05% of rdg + 0.03% of range + 0.5 μV), TC...±(0.05% of rdg +0.5℃) for K, E, J, T, L, U and KPvsAu7Fe.

**Pen Offset Compensation (Standard):** Average, max./min. recording selectable (with compensation ON/OFF switch).

**Input Impedance:** Approx. 1 MΩ (DC V & TC).

**Writing & Printing System:** Ink writing using disposable felt-tip pen cartridges (analog data), and wire-dot printer using ribbon cassette (digital data).

**Effective Recording Span:** 250 mm (analog data).

**Number of Channels:** 1, 2, 3 or 4.

**Recording Colors:**

| 1st | 2nd | 3rd | 4th |
|---|---|---|---|
| Red | Green | Blue | Brown |

**Recording Accuracy :** Measurement accuracy + ± 0.2% of effective recording span (including non-linearity, deadband and error between ranges).

**Maximum Pen Speed:** Approx. 1,600 mm/s.

**Chart:** Z-fold chart (270 mm×20 m), roll chart (270 mm×20 m)...optional

**Chart Speeds:** 10 to 1,200 mm/min & mm/h (1 mm steps), and 0.5 to 45.0 inch/min & inch/h (0.1 inch steps).

**Type of Display:** Vacuum fluorescent display (5×7 dot matrix, blue), 20 characters for each channel.

**Display Modes:** Digital data display, bar graph display, range data display.

**Number of Alarm Set Leves:** Up to 2 levels/channel.

**Alarm Types:** High (H), low (L), delta high (dH), and delta low (dL).

**Alarm Outputs (Optional):** Up to 4 points (internal, contact rating...24 V DC and AC 1 A).

**Standard Computing Functions:** Scaling (ranges...−22,000 to + 22,000) and ΔT.

**Optional Mathematical Functions*:** +, −, ×, ÷, square root, absolute value, logarithm, exponential function (up to 4 channels)
*Not available for 1-pen model.

**Standard Memory Card:** For storing the setting data (memory capacity of 8K bytes)

**Power Requirements:** 90 to 250 V AC, for both 50 and 60 Hz.

**Power Consumption:** 1 channel model...85 VA max., 45 VA balanced, 2 channel model...100 VA max., 50 VA balanced, 3 channel model...115 VA max., 55 VA balanced, 4 channel model...130 VA max., 60 VA balanced.

**Weight (Approx.):**

| Model | 1-channel | 2-channel | 3-channel | 4-channel |
|---|---|---|---|---|
| **LR4210** | 12.5 kg<br>(27.6 lbs) | 13 kg<br>(28.7 lbs) | 13.5 kg<br>(29.8 lbs) | 14 kg<br>(30.9 lbs) |
| **LR4220** | 11.5 kg<br>(25.4 lbs) | 12 kg<br>(26.5 lbs) | 12.5 kg<br>(27.6 lbs) | 13 kg<br>(28.7 lbs) |

## AVAILABLE MODELS

| Model | Suffix Codes | Description |
|---|---|---|
| **3721** | | **LR4210** Recorder<br>(with printer & electrical pen lift) |
| **3722** | | **LR4220** Recorder<br>(without printer & manual pen lift) |
| No of channels | **1** | 1-pen model |
| | **2** | 2-pen model |
| | **3** | 3-pen model |
| | **4** | 4-pen model |
| Input types & max. sensitivity | **1** | 10 mV F.S. (DC V, TC) |
| | **2** | 1 mV F.S. (DC V, TC) |
| | **3** | 0.1 mV F.S. (DC V, TC) |
| | **4** | 10 mV F.S (DC V, TC, RTD) |
| | **5** | 1 mV F.S.(DC V, TC, RTD) |
| | **6** | 0.1 mV F.S.(DCV, TC, RTD) |
| Version up | **-B** | — |
| Power requirement | **-O** | 90 to 250 V AC |
| Power cord | **/B** | JIS standard |
| | **/D** | UL standard |
| | **/F** | VDE standard |
| | **/G** | SAA standard |
| Optional features | **/GP-IB** | GPIB interface |
| | **/RS232C** | RS-232-C interface |
| | **/MATH** | Mathematical functions |
| | **/AK-04** | Alarms (internal, 4 points) |
| | **/REM** | Remote controls |
| | **/ROL** | Roll chart drive |
| | **/REROL** | Chart reroll |
| | **/DF** | F display |

## OPTIONAL ACCESSORIES

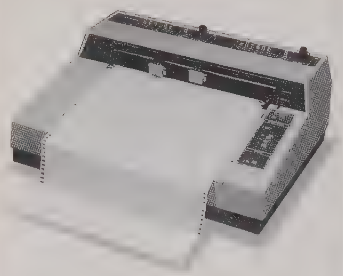
| Name | Part No. | Order Q'ty |
|---|---|---|
| IC memory card (setting & measured data, 256K bytes | **378904** | 1 unit<br>(1 pc./unit, |

## SPARES

| Name | | Part No. | Order Q'ty |
|---|---|---|---|
| Ribbon cassette (For **LR4210**) | | **B9585SH** | 1 unit<br>(1pc./unit) |
| Z-fold chart (270 mm×20 mm) | | **B9619AH** | 10 units<br>(1 pc./unit) |
| Roll chart (270 mm×20 m) | | **B9622AH** | 10 units<br>(1 pc./unit) |
| *Disposable felt-tip pen cartridge | 1st channel (red) | **B9586☐A** | 1 unit<br>(3 pc./unit) |
| | 2nd channel (green) | **B9586☐B** | |
| | 3rd channel (blue) | **B9586☐C** | |
| | 4th channel (brown) | **B9586☐D** | |
| | 1st to 4th channels | **B9586☐R** | 1 unit<br>(1 pc./unit) |
| Memory card (setting data), 8K bytes | | **378901** | 1 unit<br>(1 pc./unit) |
| Lithium battery (for mainframe) | | **B9588ZB** | |
| Lithium battery (for **378901**) | | **B9586JU** | 2 units<br>(1 pc./unit) |
| Lithium battery (for **378904**) | | **B9586JV** | |
| Dust cover | | **B9622AV** | 1 pc |
| Measurement leads (1 m) | | **B9409JA** | 1 set |

***Note:** specify **X** **Y** or **Z** in ☐
**Y** Standard (pen speed of lower than approx. 800 mm/s)
**Z** High speed (pen speed of higher than approx. 800 mm/s)
**X** Low speed (chart speed of lower than approx. 100 mm/h)

## 3021 Flatbed Pen Recorders



**3021** 435×353×192 mm 9 kg

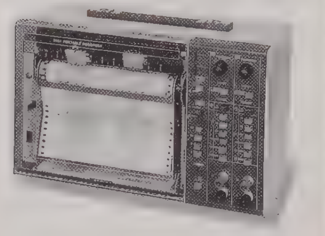
Low cost 250 mm strip chart recorders with an accuracy of ±0.25%. For long, trouble-free operation, 3021 use a non-contact ultrasonic pen position transducer and brushless DC servomotor.

**Full Scale:** 250 mm.
**Accuracy:** ±0.25% of F.S. (500 mV range).
**Pen Speed (Nominal):** 500 mm/s
**Chart Speeds:** 2, 6, 20, 60 cm/min and cm/h.
**Input Ranges:** 10 mV to 50 V F.S. (12 ranges) or single range.
**Power Requirements:** 100, 115, 200, or 230 V AC (must be specified), 48 to 63 Hz.
**Power Consumption (Approx.):** 22 VA max., 16 VA balanced (one-pen), 30 VA max., 22 VA balanced (two-pen).

### AVAILABLE MODELS

| Model | Suffix Codes | Description |
|---|---|---|
| 3021 | … | Flatbed pen recorder |
| No of pens | 1… | 1 pen |
| | 2… | 2 pens |
| Input ranges | 0 | Single range (specify range) |
| | 1 | 12 ranges |
| Optional features | /CHC | Remote chart drive control |
| | /MAK | Event marker |
| | /LIFT | Remote pen lift control |

## 3057 Portable Recorders



**3057** 223×332×174 mm

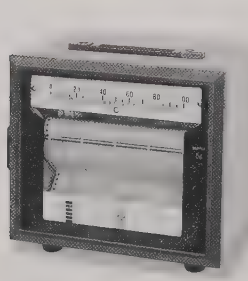
The 3057 is a compact, 150 mm portable recorders designed for virtually every application including field and laboratory uses. Exceptionally high reliability and stability are packed into a compact case. Offer a full range of features; one or two pens, Z-fold or roll chart, vertical or flatbed, and remote control option. Use a non-contact ultrasonic pen position transducer for maximum life and stability.

**Writing System:** Ink writing using disposable felt-tip pen cartridges.
**Ink Colors:** Red for 1st pen, green for 2nd pen.
**Effective Recording Span:** 150 mm.
**Accuracy:** ±0.5% of effective recording span (includes non-linearity and deadband).
**Deadband:** Less than 0.2% of effective recording span.
**Maximum Pen Speed (Nominal):** 300 mm/s.
**Chart:** Z-fold chart (174 mm×15 m), or roll chart (174 mm×20 m).
**Chart Drive:** Pulse motor drive using crystal oscillator.
**Chart Speeds:** 2, 6, 20, 60 cm/min and cm/h.
**Voltage Ranges:** 10, 20, 50, 100, 200, 500 mV, 1, 2, 5, 10, 50 V full scale.
**Weight (Approx):** 305711...5 kg, 305721...6 kg, 305712 or 305713...7 kg, 305722 or 305723...8 kg.

### AVAILABLE MODELS

| Model | Suffix Codes | Description |
|---|---|---|
| 3057 | | Portable recorder |
| No. of pens | 1 | 1 pen |
| | 2 | 2 pens |
| Power requirements | 1 | AC line...100, 115, 200, or 230 V AC (must be specified), 50 and 60 Hz |
| | 2 | AC line, internal rechargeable Ni-Cd battery and external 12 V DC |
| | 3 | AC line, internal ten 1.5 V batteries, and external 12 V DC |
| Optional feature | /CHC | Remote chart drive control |

## 3058 Multi-Point Recorders



**3058** 249×288×273 mm 12 kg

The 3058 is a compact, dependable 180 mm multi-point recorders using a self-balancing DC servo system. Provide a choice of two basic models; 6- or 12-point distinct color printing.

**Effective Scale Length:** 180 mm.
**Measuring Ranges:** 0 to 10 mV, Type K (0 to 600°C, 800°C, or 1200°C), Type T (0 to 200°C, 300°C or −50 to 150°C), or RTD (JIS or DIN Pt100, 3-wire system, −50 to 50°C, or 0 to 100°C).
**Accuracy:** ±0.5% of span.
**Deadband:** Less than 0.1% of span
**Chart:** Z-fold chart (200 mm×20 m), approx. one month recording at 25 mm/h.
**Chart Speeds:** 25, 50, 100 mm/h and mm/min
**Point Printing Interval:** 5 s at 50 Hz, 4.2 s at 60 Hz
**Power Requirements:** 100, 110, 115, 120, 200, 220, 230, or 240 V AC ±10% (must be specified), 50 or 60 Hz (selectable).
**Power Consumption:** Approx. 11 VA.
**Optional Feature:** Microswitch alarms.
**Optional Accessories:** Rack adapter, panel adapter.

### AVAILABLE MODELS

| Model | No. of Points | Input Types |
|---|---|---|
| 305861 | 6 | DC mV |
| 305866 | | TC (Type K) |
| 305867 | | TC (Type T) |
| 305868 | | RTD (Pt100) |
| 305871 | 12 | DC mV |
| 305876 | | TC (Type K) |
| 305877 | | TC (Type T) |
| 305878 | | RTD (Pt100) |

# X-Y RECORDERS

## 3023·3024·3025·3022·3036

### 3023 & 3024 X-Y Recorders

**3023** (Front-input model) 441×482×136 mm 18 kg

**3024** (Rear-input model) 399×482×136 mm 18 kg

The 3023 and 3024 are top-level, high performance A3 X-Y recorders, available in front- or rear-input models, and one- or two-pen models. All models offer the fastest slewing speed and acceleration. The slewing speed and acceleration of the one-pen model in the Y axis is 2,200 mm/s 7.6 G, and 2,000 mm/s 5.1 G in the X axis.

**Top level accuracy of ±0.2%**
**10 scales of calibrated offset**
**16 speeds of time base**

#### SPECIFICATIONS

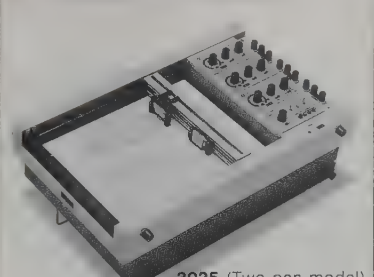
| | | |
|---|---|---|
| **Writing area** | | A3 size (381×254 mm) |
| **No. of pens** | | 1 or 2 |
| **Input ranges** | | 50 μV to 5 V/cm |
| **Accuracy** | | ±0.2% |
| **Input impedance** | | 1 MΩ |
| **Slewing speed** | **X** | 2,000 mm/s |
| | **Y** | 2,200 mm/s |
| **Paper holddown** | | Electrostatic |
| **Time base** | | 0.25 to 50 s/cm & min/cm |
| **Chart drive unit** | | Available (optional) |

#### OPTIONAL ACCESSORIES

| Name | | Model | Compatible Models |
|---|---|---|---|
| Chart drive unit | | **308941** | 3023, 3024 |
| *Rack adapter | Metric | **303571** | |
| | Inch | **303572** | |

*Note Rack adapter is required to rack-mount the **3023** or **3024** with **308941**

### 3025 X-Y Recorder



**3025** (Two-pen model) 299×413×152 mm 14 kg

The 3025 is a fast, high-performance A4 X-Y recorder, available as one- or two-pen model. Both models offer high slewing speed and high acceleration. The slewing speed and acceleration of the one-pen model in the Y axis is 2,200 mm/s 7.6 G, and 2,000 mm/s 5.1 G in the X axis.

**±0.25% accuracy, 50 μV/cm max. sensitivity**
**10 scales of calibrated offset**
**16 speeds of time base (optional)**

#### SPECIFICATIONS

| | | |
|---|---|---|
| **Writing area** | | A4 size (254×180 mm) |
| **No. of pens** | | 1 or 2 |
| **Input ranges** | | 50 μV to 5 V/cm |
| **Accuracy** | | ±0.25% |
| **Input impedance** | | 1 MΩ |
| **Slewing speed** | **X** | 2,000 mm/s |
| | **Y** | 2,200 mm/s |
| **Paper holddown** | | Electrostatic |
| **Time base** | | 0.25 to 50 s/cm & min/cm |
| **Chart drive unit** | | Available (optional) |

#### OPTIONAL ACCESSORIES

| Name | Model | Description |
|---|---|---|
| Chart drive unit | **308951** | Chart stock option is required |
| *Rack adapter | **303581** | Metric |
| | **303582** | Inch |

*Note Rack adapter is required to rack-mount the **3025** with **308951**

### 3022 X-Y Recorder

**3022**
438×267×102 mm 6.7 kg

The 3022 is a low-cost, one-pen X-Y recorder that accepts either DIN A4 (210×297 mm) or 8-1/2×11 inch size chart. To eliminate many moving parts to assure optimum reliability, 3022 uses a non-contact ultrasonic pen position transducer and brushless DC servomotor. A disposable felt-tip ink pen ensures clean, high-quality traces.

**High accuracy — ±0.25% of full scale**
**Maximum reliability through the use of non-contact servo elements**

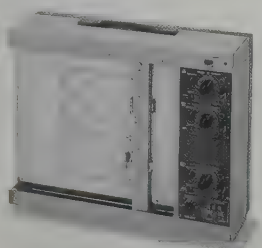
#### SPECIFICATIONS

| | | |
|---|---|---|
| **Writing area** | | A4 size (250×180 mm) |
| **No. of pens** | | 1 |
| **Input ranges** | | 0.5 mV to 2.5 V/cm |
| **Accuracy** | | ±0.25% |
| **Input impedance** | | 1 MΩ |
| **Slewing speed** | **X** | 300 mm/s |
| | **Y** | 500 mm/s |
| **Paper holddown** | | Mechanical |
| **Time base** | | 0.25 to 10 s/cm & min/cm |

#### OPTIONAL ACCESSORIES

| Model | Description |
|---|---|
| **302901** | Rack Adapter (for ANSI or JIS size rack) |
| **302903** | Dust Cover |

### 3036 X-Y Recorder



**3036** (25 cm×25 cm, two pen model)
349×433×147 mm 14 kg

The 3036 is a high-quality one- or two-pen X-Y recorder designed to assure long-term reliable recording with high performance and durability. The 3036 has a writing area of 25 cm×25 cm, and operates with DIN A4 size paper or roll charts with an accuracy of ±0.25% and maximum sensitivity of 5 μV/cm.

**Long-life, reliable brushless DC servomotor**
**Built-in time base**

#### SPECIFICATIONS

| | | |
|---|---|---|
| **Writing area** | | 250×250 mm |
| **No. of pens** | | 1 or 2 |
| **Input ranges** | | 5 μV to 5 V/cm |
| **Accuracy** | | ±0.25% |
| **Input impedance** | | 1 MΩ |
| **Slewing speed** | **X** | 500 mm/s |
| | **Y** | 500 mm/s |
| **Paper holddown** | | Electrostatic |
| **Time base** | | 0.25 to 10 s/cm |
| **Chart drive unit** | | Available (optional) |

#### OPTIONAL ACCESSORIES

| Name | Model | Chart speeds | Description |
|---|---|---|---|
| Chart Drive Unit | **308921** | 1, 3, 10, 30 cm/min | Weight approx. 2.2 kg |
| | **308923** | 2, 6, 20, 60 cm/h | |

# PERIPHERAL EQUIPMENT

## 3131 · 3132 · 3133 · 3134 · 345810 · 3105 · 3106 · 3161

**313402**
138×42×374 mm
2.2 kg

**2555***
138×42×374 mm
2.2 kg

**3131**
138×42×374 mm
2.2 kg

**3132**
138×42×374 mm
1.9 kg

**3133**
138×42×374 mm
2.2 kg

**3161**
138×84×374 mm
3.0 kg

*Shown in the product group of "Voltage Current Standards"

For signal conditioning, it is important to select the most appropriate combination of detectors, converters, amplifiers and recorders. The table below provides an outline of YOKOGAWA's peripheral equipment for use with recorders and oscillographs.

| Instrument Name | Model | Main Use | Major Specifications |
|---|---|---|---|
| DC Amplifier | **3131** | High-sensitivity measurements, amplification of minute signals, isolator | **Gain Range:** 1 to 10,000<br>**Max. Output:** ±10 V/±50 mA<br>**Output Linearity:** ±0.05%<br>**Input Impedance:** 10 MΩ<br>**Frequency Response:** DC to 5 kHz |
| DC Amplifier | **3132** | General-purpose isolation amplifier | **Gain Range:** 0.1 to 100<br>**Max. Output:** ±10 V/±50 mA<br>**Output Linearity:** ±0.05%<br>**Input Impedance:** 1 MΩ<br>**Frequency Response:** DC to 5 kHz |
| DC Amplifier | **3133** | General-purpose, direct-coupled DC amplifier (2 channels) | **Gain Range:** 0.1 to 50<br>**Max. Output:** ±10 V/±50 mA<br>**Output Linearity:** ±0.05%<br>**Input Impedance:** 150 kΩ<br>**Frequency Response:** DC to 10 kHz |
| Strain Amplifier | **3134** | Dynamic strain measurement with high sensitivity and good noise performance (using AC bridge) | **Measuring Ranges:** ±200 to ±10,000×$10^{-6}$ strains<br>**Max. Sensitivity:** 0.5 V/10×$10^{-6}$ strains<br>**Output Voltage:** ±10 V/50 mA<br>**Available Models: 313401**...manual bridge balance,<br>**313402**...automatic (digital) bridge balance |
| Signal Conditioner | **345810** | High precision strain measurement or as data amplifier | **Number of Channels:** 1<br>**Input Ranges:** ±10,000 to 100,000 μstrains, ±10 to 100 mV<br>**Input Resistance:** 1 MΩ<br>**Max. Output:** 10 V (50 mA) |
| Series Resistor | **3105** | High voltage measurement up to 200 V rms | **Number of Channels:** 2<br>**Rated Resistance:** 1 to 500 kΩ<br>**Current Limit:** Less than 200 V rms or 40 mA rms |
| Shunt Resistor | **3106** | Large current measurement up to 5 A rms | **Number of Channels:** 2<br>**Rated Resistance:** 0.2 Ω<br>**Current Limit:** Less than 5 A rms |
| F V Converter | **3161** | Measurement of frequency and rotational speed | **Input Ranges:** 0.1 Hz to 10 kHz (6 to 600,000 rpm)<br>**Input Impedance:** 100 kΩ<br>**Output:** 10 V/F.S., 50 mA/F.S., and calibration signal |

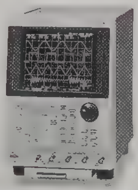
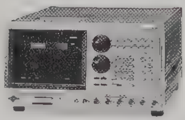
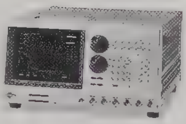
# Selection Guide

Although the history of digital oscilloscopes is short compared with that of analog oscilloscopes, they have the capability to break the barriers of analog oscilloscopes by realizing functions and performance that conventional analog oscilloscopes have not been able to achieve, through the advantages of digital technology.

YOKOGAWA has developed a digital oscilloscope, DL Series with unique functions and performance based on an entirely new concept, and applying state-of-the-art technologies to the digital oscilloscope field.

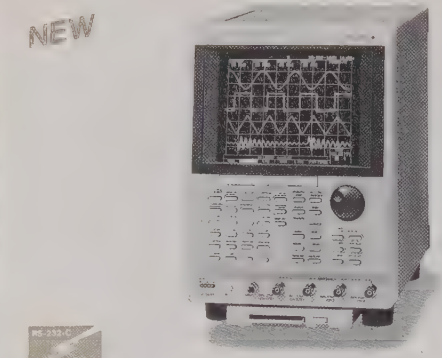
The DL Series features large memory length, powerful triggering system and abundant set of computing functions, which are new standards for digital oscilloscopes.

## SELECTION GUIDE

| | | |  |  |  |
|---|---|---|---|---|---|
| **Item** | | **Model** | [illegible] | [illegible] | [illegible] |
| **Maximum sampling rate** | | | 100 MS/s | 200 MS/s | 25 MS/s |
| **Effective storage frequency bandwidth** | **Single-shot** | | 40 MHz | 80 MHz | 10 MHz |
| | **Repetitive** | | 100 MHz | 300 MHz | 10 MHz |
| **Vertical resolution** | | | 8 bits | 8 bits | 12 bits |
| **Number of input channels** | | | 4 ch | 2 ch | 2 ch |
| **Memory length** | **Per channel** | | 32k words | 32/128k words | 256k words (STD)<br>512k words (OPT) |
| | **1 CH mode** | | 128k words | — | 512k words (STD)<br>1M words (OPT) |
| **Triggering function** | **IPD trigger** | | — | ○ | — |
| | **Glitch trigger** | | | ○ | — |
| | **Multigate trigger** | | — | ○ | ○ |
| | **Combination trigger** | **Serial pattern trigger** | | ○ | ○ |
| | | **Parallel pattern trigger** | | ○ | ○ |
| | **TV trigger** | | ○ | — | |
| | **Level trigger** | | ○ | ○ | ○ |
| **Computing function** | **Waveform parameter** | | ○ | ○ | ○ |
| | **Averaging** | | ○ | ○ | ○ |
| | **Hilbert transform, phase function** | | — | ○ | ○ |
| | **Frequency (Histogram)** | | | ○ | ○ |
| | **FFT analysis** | | | ○ | ○ |
| | **Digital filter** | | — | ○ | ○ |
| | **Integration and differentiation** | | — | ○ | ○ |
| | **Square root extraction (SQR)** | | — | ○ | ○ |
| | **Exponential function (EXP)** | | | ○ | ○ |
| | **Logarithm (LOG)** | | — | ○ | ○ |
| | **Inversion (INV)** | | | ○ | ○ |
| | **Absolute value (ABS)** | | | ○ | — |
| | +,−,×,÷ | | (+,−,× only) | ○ | ○ |
| **Hard copy** | | | Built-in (Optional) | Built-in (Optional) | Built-in (Optional) |
| **Differential input** | | | — | — | — |
| **DC offset** | | | | — | |
| **Pattern search** | | | | — | |
| **GO NO GO function** | | | | — | |
| **Auto setup** | | | — | — | ○ |

Note: ○...Available, —...Not available

# DL1200A Portable Digital Oscilloscope 7006



**7006** 271×205×303 mm 8 kg

The DL1200A is equipped for full-range 4-channel inputs. It offers high performance, with a frequency bandwidth of 100 MHz, maximum sampling rate of 100M samples/s, and a memory capacity of 128k words.

The DL1200A is truly a "personal" low cost digital oscilloscope which incorporates the essence of DL Series technology in a small affordable package with an A4-size footprint and A4-size front panel.

**Full range 4 channels**

Each channel has its own attenuator, preamplifier and A-D converter which enables full range (2 mV to 5 V/div.) measurements and simultaneous signal sampling. The DL1200A is best suited for simultaneous measurement of multiple phenomena.

**Frequency bandwidth of 100 MHz**

Frequency bandwidth is 100 MHz on all four channels. Adoption of random equivalent time sampling enables time resolutions of 200 ps (equivalent to 5G samples/s).

**High speed signal sampling of up to 100M samples/s**

Although the effective sampling rate in 4 channel simultaneous measurement is 20M samples/s, the incorporation of an A-D converter of up to 25M samples/s for each DL1200A channel used in time sharing operations enables sampling rates as high as 50M samples/s when using 2 channels simultaneously and 100M samples/s when using only one channel.

The alternate mode, however, realizes measurements in 100M samples/s for all 4 channels.

**Large memory capacity (128k words)**

The DL1200A has a large 32k-word memory for each channel. The memory can be used effectively corresponding to the number of channels used, e.g. 64k words/channel can be used as acquisition memory for 2 channels and 128k words for 1 channel use.

**Designed with compact A4-size footprint and A4-size front panel**

The DL1200A is small and lightweight with a width of 205 mm (8-1/8"), height of 271 mm (10-3/4"), depth of 303 mm (12")and a weight of 8 kg(17.7 lbs). It is a personal unit in the sense that it can be conveniently used at one's bench.

**Built-in printer (optional) prints out the display screen.**

Captured waveforms on the screen can be printed out with a single touch-key operation (paper width 112 mm). Troublesome photographing with a camera or connecting an external printer is not necessary. A GBIB interface is provided as standard. Waveform data or panel settings can be simply saved/loaded with an optional IC memory card. Unmanned recording is also available by combining the DL1200A with a GO/NO-GO automatic decision function.

## MAINFRAME SPECIFICATIONS

| | | |
|---|---|---|
| Vertical | **Frequency bandwidth (−3 dB point)** | DC to 100 MHz (All ranges) |
| | **Number of input channels** | 4 channels |
| | **Vertical axis sensitivity** | 2 mV/div to 5 V/div (1-2-5 steps) |
| | **Vertical axis accuracy (directly after the auto-calibration)** | ±(2.5% of 8 div +1 LSB),(On reference range 100 mV/div) |
| | **Maximum input voltage** | 250 V (DC+AC peak, maximum at 1 kHz) |
| | **Input impedance** | 1 MΩ±1.5% (in parallel with approx. 27 pF) |
| | **Input coupling** | AC, DC, GND |
| Horizontal | **Sweep time** | 10 ns/div to 50 s/div |
| | **Time axis accuracy** | ±(0.01%+500 ps) |
| | **Window** | Zooming and scrolling are possible. Maximum of 1,000 magnification |
| Digitizer | **Effective storage frequency bandwidth (−3 dB point)** | Periodic: 100 MHz. Single-shot 40 MHz (Single phenomenon or alternate mode), 20 MHz (2 simultaneous phenomena), 8 MHz (3 or 4 simultaneous phenomena) |
| | **Maximum sampling rate** | 100M samples/s (Single phenomenon or alternate), 50M samples/s (2 simultaneous phenomena), 20M samples/s (3 or 4 simultaneous phenomena) |
| | **Maximum memory size** | 128k words (Single phenomenon, single-shot), 64k words/ch (2 simultaneous phenomena, single shot), 32k words/ch (3 or 4 simultaneous phenomena single-shot), 10k words/ch (Normal) |
| | **Vertical axis resolution** | 8 bit (25 LSB/div.) |
| Trigger | **Trigger mode** | Normal, Auto, Auto level, Single (Short memory, long memory) |
| | **Trigger source** | CH1, CH2, CH3, CH4, LINE |
| | **Trigger coupling** | DC, AC, HFrej, TV |
| | **TV trigger** | Field and line can be specified. Corresponding system: NTSC, PAL |
| | **Trigger slope** | Rise, Fall, Rise and Fall |
| | **Trigger sensitivity** | 1 div (DC to 100 MHz) |
| Display | **CRT** | Size 7 inch (Raster scan) Phosphor color Amber |
| Communications | **GPIB** | A direct plotter/printer output function is available |
| | **RS-232-C (optional)** | |
| Printer (Optional) | **Printing system** | Thermal line dot method |
| | **Paper width** | 112 mm |
| Others | **Memory card slots** | One slot for IC memory card (Optional accessory) |
| | **Signal output** | Trigger output TTL level, CH1 output Approx. 20 mV/div,<br>GO/NO GO result output TTL level |
| | **Calibration output (CAL signal)** | 1 kHz |
| General Specifications | **Power requirements** | 90 to 132 V AC or 180 to 250 V AC, 48 to 63 Hz |
| | **Power consumption** | 150 VA max |

## AVAILABLE MODELS

| Model | Suffix Codes | | | Description |
|---|---|---|---|---|
| 700620 | | | | **DL1200A** Digital Oscilloscope |
| Power Requirements | -1 | | | 90 to 132 V AC |
| | -5 | | | 180 to 250 V AC |
| Power Cord | | /D | | UL Standard |
| | | /F | | VDE Standard |
| | | /H | | SAA Standard |
| | | /J | | BS Standard |
| | | /M | | JIS Standard grounded cable** |
| Optional Features | | | /PRN | Built-in printer* |
| | | | /RS232C | RS-232-C interface |
| | | | /CARDIF | IC memory card function |

Notes * One roll of paper is supplied as a standard accessory
** JIS standard grounded cable consists of UL standard power cord and 3-pin to 2-pin adapter

## OPTIONAL ACCESSORIES

| Name | Optional Code | Description | Order Q'ty |
|---|---|---|---|
| Lithium battery | **B9586JV** | For IC memory card | 2 units (1 pc./unit) |
| Miniclip converter | **700971** | Probe accessory | 1 unit [illegible] |
| BNC adapter | **700972** | Probe accessory | |
| Ground lead | **700973** | Probe accessory | |
| Cleaning kit | **700921** | For CRT | |

## SPARES

| Name | Part No. | Description | Order Q'ty |
|---|---|---|---|
| Printer paper roll | **B9850NX** | 30 m (one roll per unit) | 5 |
| Voltage probe* | **700952** | 10 MΩ(10:1)<br>1.5 m(one per unit) | 1 |

* Four probes are supplied as standard accessory

# DL2100B Digital Oscilloscope 7002

**700241** 221×426×524 mm 19.5 kg

The DL2100B Series of digital oscilloscope is based on a new concept making extensive use of digital measurement features free from conventional oscilloscope limitations.

High speed sampling, enhanced trigger set, fast computing functions using 32-bit signal processor, large memory capacity of 128k words/channel, are the new standards for the digital oscilloscope.

**8-bit, 200M samples/s, simultaneous 2-channel sampling and 128k word/channel large memory**

The DL2100B can observe waveforms which are impossible to capture with conventional digital oscilloscopes by virtue of this large memory.

**Repetitive signals with 300 MHz bandwidth (50 Ω input)**

Equivalent time sampling techniques enable digitizing of repetitive signals of up to 300 MHz. Furthermore, due to random sampling, pretriggering is possible.

**Clear sharp waveform display**

The CRT has 800×576 dot resolution. A pleasant amber phosphor type display helps reduce eyestrain.

**Enhanced Trigger Set (E.T.S)**

Complex, highspeed waveforms which cannot be captured with conventional level triggering systems are reliably captured with the E.T.S. The E.T.S includes Multigate, Serial Pattern, Parallel Pattern, Combination (Serial and Parallel Pattern), Glitch, and IPD (Inter-Pattern Distance) triggering modes.

**Abundant set of computing functions including FFT function**

The DL2100B Series offers the following computation and signal processing functions in addition to the four basic arithmetic operations (+, −, ×, ÷,). Absolute value, common logarithm, exponential, square root, integral, double integral, differential, 2nd-order differential, histogram, digital filtering, Hilbert transform, phase function, arc tangent, linear spectrum, phase, power spectrum, power spectrum density and programs (user-defined formulas).

## MAINFRAME SPECIFICATIONS

| | | |
|---|---|---|
| Vertical (Channel 1, 2) | **Frequency bandwidth** (-3 dB point) | DC to 200 MHz (1 MΩ input)/DC to 300 MHz (50 Ω input) |
| | **Number of input channels** | Two channels (up to four channels can be simultaneously displayed when including the channel 3 and 4 trigger states) |
| | **Vertical axis sensitivity/accuracy** | 5 mV/div to 5 V/div (1-2-5 steps)... 1 MΩ input, 20 mV/div to 1 V/div (1-2-5 steps)...50 Ω input ±(2%+1 LSB) (on reference range... 100 mV/div, 1 MΩ) |
| | **Maximum input voltage** | 1 MΩ input: 400 V (DC+AC peak, at less than 1 kHz), 50 Ω input: 5 Vrms, 10 V peak |
| | **Input impedance** | 1 MΩ±1% (in parallel with approx. 22 pF) (1 MΩ input) |
| | **VSWR** | Less than 1.5:1 at 300 MHz (50 Ω input) |
| **Horizontal** | **Sweep time** | 10 ns/div to 50 s/div (1-2-5 steps), (when displaying 1k words) |
| | **Time axis accuracy** | ±(0.005%+200 ps) |
| | **External time base input** | 1 to 100 MHz, 0 to 4 dBm |
| | **Delay time** | Post: 16×10⁶ data samples. Pre: 100% of record length |
| **Digitizer** | **Effective storage frequency bandwidth** (−3 dB point) | Single-shot: 80 MHz<br>Repetitive: 200 MHz (1 MΩ input)/300 MHz (50 Ω input) |
| | **Max. sampling rate** | 2-channel simultaneous, 200M samples/s |
| | **Vertical axis resolution** | 8-bit (25 LSB/div), except 7 bit for channel 1 or 2 when Channel 3 or 4 trigger state on display |
| | **Memory capacity** | 128 kW (**DL2120B, DL2130B, DL2140B**), 32 kW (**DL2110B**) |
| **Level trigger** | **Trigger source** | CH1, CH2, CH3, CH4 |
| | **Trigger mode** | Auto, Normal, Single, Free |
| | **Trigger slope** | Rise, Fall, Rise or Fall |
| | **Trigger sensitivity** (CH1, CH2) | DC to 50 MHz 0.8 div, 200 MHz 3 div (with 1% hysteresis) |
| **Enhanced trigger** | **Combination trigger** | Combination of serial pattern and parallel pattern |
| | **Multigate trigger** | Up to four gates may be set (**DL2130B** and **DL2140B** only). Not usable during equivalent time sampling |
| | **Glitch trigger** | Glitch width setting range: 5/10/20 ns (**DL2130B** and **DL2140B** only) |
| | **IPD trigger** | Pattern-to-pattern separation setting range: 5/10/20 ns (**DL2130B** and **DL2140B** only) |
| **Display** | **CRT** | Size: 9-inch (Raster scan), Phosphor color: Amber |
| **Communications** | **GPIB** | A direct plotter/printer output is available. |
| | **RS-232-C** (optional) | |
| **Printer (Optional)** | **Printing system** | Thermal line dot method |
| | **Paper width** | 112 mm (4-7/16") |
| **Others** | **IC memory card slots** | Two slots for memory cards (optional accessory) |
| | **Signal output** | ARM OUT. TTL level, TRIG OUT*: TTL level (optional), COMPARE OUT: TTL level (optional)* |
| | **Calibrated output** | 1 kHz |
| **General specifications** | **Power requirements** | 90 to 132 V/180 to 250 V AC (must be specified) |
| | **Power consumption** | 500 VA max |

*TRIG OUT and COMPARE OUT are applicable for **DL2120B** and **DL2140B**

## MODEL AND SUFFIX CODES

| Model | Suffix Codes | | Description |
|---|---|---|---|
| **7002** | ··· | ·················· | **DL2100B** Digital Oscilloscope Series |
| Function | **10** | ·················· | **DL2110B** (basic model 32 kW memory) |
| | **21** | ·················· | **DL2120B** (waveform analysis model: 128 kW memory) |
| | **31** | ·················· | **DL2130B** (trigger enhanced model. 128 kW memory) |
| | **41** | ·················· | **DL2140B** (super function model 128 kW memory) |
| Power Requirements | **-1** | ················ | 90 to 132 V AC |
| | **-5** | ················ | 180 to 250 V AC |
| Power Cord | **/D** | ········· | UL Standard |
| | **/F** | ········· | VDE Standard |
| | **/H** | ········· | SAA Standard |
| | **/J** | ········· | BS Standard |
| | **/M** | ········· | JIS Standard grounded cable** |
| Optional Features | **/PRN** | | Built-in printer* |
| | **/RS232C** | | RS-232-C interface |
| | **/OUT** | | TRIG OUT, COMPARE OUT*** |

Notes:
* One roll of paper is supplied as a standard accessory.
** JIS standard grounded cable consists of UL standard power cord and 3-pin to 2-pin adapter
*** /**OUT** is applicable for **DL2120B** or **DL2140B**

## OPTIONAL ACCESSORIES

| Name | Part Number | Description | Order Q'ty |
|---|---|---|---|
| IC memory card | **700904** | 512k bytes | 1 unit (1 pc/unit) |
| IC memory card | **700902** | 256k bytes | 1 unit (1 pc/unit) |
| IC memory card | **700903** | 64k bytes | 1 unit (1 pc/unit) |
| Lithium battery | **B9586JV** | For memory card | 2 units (1 pc/unit) |
| Miniclip converter | **700971** | Probe accessory | 1 unit (1 pc/unit) |
| BNC adapter | **700972** | Probe accessory | 1 unit (1 pc/unit) |
| Ground lead | **700973** | Probe accessory | 1 unit (1 pc/unit) |
| Carriage | **700991** | Specialized carriage for DL and AG series | 1 unit (1 pc/unit) |
| Cleaning kit | **700921** | For CRT display | 1 unit (1 pc/unit) |

## SPARES

| Name | Part Number | Description | Order Q'ty |
|---|---|---|---|
| Printer roll paper | **B9850NX** | 30 m (one roll per unit) | 5 units (1 roll/unit) |
| * Probe | **700951** | 10 MΩ (10:1),<br>1.5 m (one per unit) | 1 unit (1 pc/unit) |

* Note: Two probes are supplied as standard accessories

## DL3100B Digital Oscilloscope 7003

**700320** 221×426×524 mm 19.5 kg

The DL3100B features 12-bit high resolution, max. 25M samples/s and a large memory capacity of 1M words (using one channel, optional), which enables it to completely surpass conventional digital oscilloscope performance.

For example, it possesses high vertical axis resolution and can capture long duration single-shot phenomenon, while maintaining high resolution. Now, in fields ranging from electromechanical to biomedical, phenomena previously not seen are being analyzed.

**12-bit resolution, 25M samples/s simultaneous 2-channel sampling, 10 MHz analog bandwidth**

The DL3100B Series incorporates a unique 2-step type A-D converter with superior dynamic accuracy and high resolution, developed by YOKOGAWA.

**Large memory capacity of 512k words/channel max. Using one channel, 1M-word memory is available**

Long duration waveform observations of up to 40.96 ms are now possible even at the sampling rate of 25M samples/s.

**High-sensitivity differential input**

The DL3100B has highly sensitive differential input with + and − terminals. Its highest sensitivity range is 200 μV/div., with an A-D converter vertical resolution as high as 12 bits.

**Complex waveform capture by Enhanced Trigger Set (E.T.S.)**

The DL3100B has multi-gate, parallel pattern, serial pattern, and combination trigger functions. The DL3100B can capture complex waveforms which cannot be triggered by conventional oscilloscopes.

**Enhanced computing functions, including FFT analysis**

Enhanced computing functions of DL2100B and FFT analysis functions are incorporated in the DL3100B. Since the A-D converter has high 12-bit resolution, a large dynamic range is available for spectrum data obtained using an FFT.

### MAINFRAME SPECIFICATIONS

| | | |
|---|---|---|
| **Vertical** (**Channel 1, 2**) | **Frequency bandwidth** (-3 dB point) | DC to 10 MHz (20 mV/div. to 10 V/div.),<br>DC to 5 MHz (200 μV/div. to 10 mV/div.) |
| | **Number of input channels** | 2 channels differential input, + or − input coupling can be set independently. (AC/DC/GND) (4 phenomena can be displayed simultaneously including CH3 and CH4 trigger status.) |
| | **Vertical axis DC accuracy** (after auto-calibration) | ±(0.5%+0.02 div.)... 2 mV/div. to 10 V/div., ±(2.5%+0.02 div.)...2 mV/div. to 10 mV/div., ±(5%+0.02 div.)... 200 μV/div. to 1 mV/div |
| | **Input analog filter** | 6 dB/oct. roll-off characteristics, High pass filter cut-off point...100 Hz, 1, 10, 100 kHz (selectable), Low pass filter cut-off point...1 MHz, 100, 10, 1 kHz (selectable) |
| | **Maximum input voltage** | ±250 V (DC+AC peak, maximum at 1 kHz) |
| | **Input impedance** | 1 MΩ±0.5% (in parallel with approx. 33 pF) |
| | **Common mode input rejection ratio** (CMRR) | −65 dB or less (DC to 1 kHz)... 200 μV to 100 mV/div.<br>−55 dB or less (DC to 1 kHz)... 200 mV/div. to 10 V/div. |
| **Horizontal** | **Sweep time** | 4 μs/div., 5 μs/div. to 50 s/div. (1-2-5 steps) (when 1k words are displayed) |
| | **External time base input** | 0 to 30 MHz, 0 to 20 dBm |
| | **Delay time** | Pre-trigger... Record length×(-100%) max.,<br>Post-trigger... 16×10⁶ data max. |
| **Digitizer** | **Max. sampling rate** (2 channels simultaneously) | 25M samples/s (when an internal time base is used.),<br>30M samples/s (when an external time base is used) |
| | **Vertical axis resolution** | 12-bit (400 LSB/div.). However, 11-bit for CHs 1 and 2 while trigger status of CHs 3 and 4 is displayed |
| | **Memory capacity** | 256k words/CH (512k words in 1 channel mode),<br>512k words/CH (1M words in 1 channel mode) optional |
| **Level Trigger** | **Trigger source** | CH1, CH2, CH3, CH4, LINE |
| | **Trigger mode** | Auto, Normal, Single, Free |
| | **Trigger slope** | Rise, Fall, Rise/Fall |
| | **Trigger sensitivity** (CH1, CH2) | 0.5 div. (with 1% hysteresis) |
| **Enhanced Trigger** | **Combination trigger** | Combination of serial and parallel patterns |
| | **Multi-gate trigger** | Up to 4 gates may be set. |
| **Display** | **CRT display** | Size. 9 inch (Raster scan), Phosphor color: Amber |
| **Communication** | **GPIB, RS-232-C** (Optional) | A direct plotter/printer output function is available |
| **Printer** (**Optional**) | **Printing system** | Thermal line dot method |
| | **Paper width** | 112 mm (4-7/16") |
| **Others** | **IC memory card slot** | 2 slots (IC memory card is an optional accessory.) |
| | **Signal output** | ARM OUT: TTL level, COMPARE OUT: TTL level (Option for **DL3120B**) |
| | **Trigger output** | TTL level, 50 Ω output |
| | **Multiple interconnection** | Synchronous operation of one master and from one to three slave instruments connected with synchronous cables (optional accessory) |
| | **Calibration output** | 1 kHz |
| **General Specifications** | **Power supply** | 90 to 132 V AC or 180 to 250 V AC (must be specified), 48 to 63 Hz |
| | **Power consumption** | 400 VA max |

### AVAILABLE MODELS

| Model | Suffix Codes | | | | Description |
|---|---|---|---|---|---|
| **7003** | … | … | … | ……… | **DL3100B** Digital Oscilloscope Series |
| Function | **10** | … | … | ……… | **DL3110B** (basic model) |
| | **20** | … | … | ……… | **DL3120B** (waveform analysis model) |
| Power Requirements | | **-1** | … | ……… | 90 to 132 V AC |
| | | **-5** | … | ……… | 180 to 250 V AC |
| Power Cord | | | **D** | ……… | UL Standard |
| | | | **F** | ……… | VDE Standard |
| | | | **/H** | ……… | SAA Standard |
| | | | **J** | ……… | BS Standard |
| | | | **/M** | ……… | JIS Standard grounded cable** |
| Optional Features | | | | **/PRN** | Built-in printer* |
| | | | | **/RS232C** | RS-232-C interface |
| | | | | **EXTMEM** | Extended memory (512 kW CH) |
| | | | | **/OUT** | Compare output (DL3120B only) |

Notes * One roll of paper is supplied as a standard accessory
** JIS standard grounded cable consists of UL standard power cord and 3-pin to 2-pin adapter

### OPTIONAL ACCESSORIES

| Name | Code | Order Q'ty |
|---|---|---|
| IC memory card (setting & measured data) 512k bytes | **700904** | 1 unit (1 pc./unit) |
| IC memory card (setting & measured data) 256k bytes | **700902** | |
| IC memory card (setting & measured data), 64k bytes | **700903** | |
| Lithium battery for memory card | **B9586JV** | 2 units (1 pc./unit) |
| Mini clip converter (Probe accessory) | **700971** | 1 unit (1 pc./unit) |
| BNC adapter | **700972** | |
| Ground lead | **700973** | |
| Synchronous cable | **700941** | |
| Voltage probe (10 MΩ, 10:1, 1.5 m) | **700951** | |
| Carriage (specialized carriage for DL and AG Series) | **700991** | |
| Cleaning kit for CRT | **700921** | |

### SPARES

| Name | Part No. | Description | Order Q'ty |
|---|---|---|---|
| Printer paper roll | **B9850NX** | 30 m | 5 units (1 roll/unit) |
| Differential probe | **700961** | 1 MΩ(1:1), 1.5 m | 1 unit (1 pc./unit) |

# ARBITRARY WAVEFORM GENERATORS

## Selection Guide

An arbitrary waveform generator is a new type of signal generator which can create and output waveforms freely. It can generate complex waveforms which cannot be generated by conventional function generators or synthesizers. With the increasing complexity of electronic equipment, conventional signal sources can no longer sufficiently evaluate their characteristics, thus the applications for arbitrary waveform generators are expanding rapidly.

The AG Series is a waveform generator which first creates a waveform as digital signals in memory and which then outputs them as analog signals using a D-A converter. For this purpose, abundant means for waveform creation are provided. The AG Series supports three methods:

**Mathematical formulas:** A waveform is defined with a time function y=f(t).

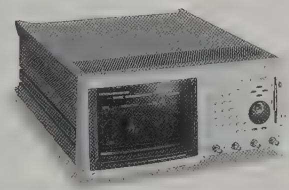
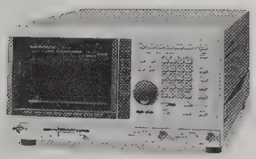
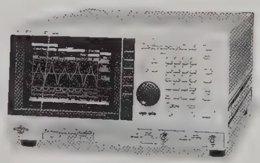
Types of functions ...SIN, COS, TAN, TAN$^{-1}$, EXP, LOG, square root extraction (SQRT), absolute value (ABS), integer (INT), noise function, phase shift.

**Scope draw:** Waveforms are freely created using the CRT screen as a canvas. The rotary knob is used to make a rough sketch of waveforms with dots and then interpolation is used between the dots. This can also be applied to modification of portions of a waveform.

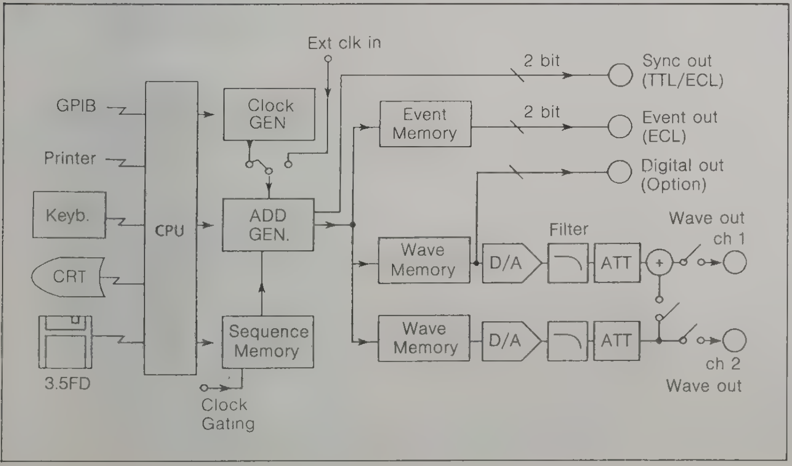
Types of interpolations...Linear and spline (connecting with smooth curves) interpolations.

**Actual waveforms:** Actual waveforms caught by digital oscilloscopes or other instruments are downloaded via a GPIB interface. Data transfer can be directly carried out without a personal computer by using YOKOGAWA's DL Series Data Transfer Function.

### SELECTION GUIDE

| |  |  |  |
|---|---|---|---|
| **Item** **Model** | [illegible] | [illegible] | [illegible] |
| **Number of channels** | 1, 2 or 4 | 1 or 2 | 1 or 2 |
| **Clock rate** | 10 mHz to 10 MHz (Resolution 10 mHz) | 1 Hz to 100 MHz (Resolution 1 Hz) | 1 Hz to 200 MHz (Resolution 1 Hz) |
| **DA resolution** | 12 bits | 10 bits | 8 bits |
| **Maximum output voltage** | 10 $V_{p-p}$(±5 V), (50 Ω load, attenuator at 0 dB) | 2 $V_{p-p}$(±1 V), (50 Ω load, attenuator at 0 dB) | 2 $V_{p-p}$(±1 V), (50 Ω load, attenuator at 0 dB) |
| **Filter** | 500k/1M/2M/5M/Sharp (2.7 MHz) | 2/5/10/20/50 MHz | 2/5/10/20/50/100 MHz |
| **Waveform memory** | 10 W to 16,000 W (in 1 W step) | 32 W to 8 KW (in 8 W step) | 64 W to 8 KW (in 16 W step) |

### BASIC PRINCIPLE OF AN ARBITRARY WAVEFORM GENERATOR



# AG1200 Arbitrary Waveform Generator 7051

**705142** 177×426×441 mm 13 kg

The AG1200 is an arbitrary waveform generator, featuring clock rate of 10 MHz and 12-bit D-A resolution. The AG1200 offers four-channel output, and further more, maximum four units of AG1200 can be connected in parallel to simultaneously simulate waveforms up to 16 channels. Among four channels, two channels can be used as a pattern generator to provide maximum 32-bit digital patterns. Mixed output in analog and digital forms can be performed to test micro-processor based instruments. The AG1200 has three ways to generate waveforms, which are: (1) Mathematical formulas, (2) Scope draw and (3) Download from digital oscilloscope.

**Simultaneous output of four channels**

The AG1200 features four-channel simultaneous output including arbitrary waveforms as well as function generators.

**12-bit D-A (max. 10 MHz clock)**

High resolution and wide dynamic range.

**Large memory capacity (32k words/channel)**

A large memory capacity allows output of long periodic waveforms or one-shot waveforms of long duration. Waveform elements can be joined together and looped with sequence programming.

**Analog waveforms plus digital patterns (for the 705142 only)**

Simultaneous output of analog waveforms and digital patterns enables to simulate micro-processor control signals.

**Abundant waveform output**

The AG1200 comes with three output modes, which are; (1)Arbitrary waveform mode, (2) Function generator mode, (3) Digital pattern output mode (705142 only). Output modes can be combined on a channel-by-channel basis.

**Abundant waveform generation**

Three types of easy-to-use waveform creating functions are available.

## MAINFRAME SPECIFICATIONS

| | | | |
|---|---|---|---|
| **Analog Output**[1] | **Output channels** | | 1, 2 or 4 channels |
| | **Maximum output voltage** | | ±10 V (without load) |
| | **Output impedance** | | 50 Ω±5%(DC) |
| | **Output resolution** | | 12 bits |
| **Arbitrary Waveform Output** | **DC accuracy**[2] | | ≦±(0.3% of setting+15 mV+FSATT accuracy) |
| | **DC stability** | | ≦±(300 ppm of setting + 2 mV)/°C |
| | **Attenuator (FSATT)** | **Setting range** | 0 to 60 dB (0.001 dB resolution) |
| | | **DC accuracy** | ±(0.5% of setting (dB)+ 0.02 dB) |
| | **Filter** | | 500k/1M/2M/5M/SHARP(2.7 MHz)/OFF |
| | **Rise time** | | ≦70 ns(10 to 90%, with filter off) |
| | **Interchannel skew** | | ≦±25 ns (CH1 base, with filter off) |
| | **Interchannel crosstalk (typical)** | | −70 dB |
| | **Output noise (typical value)** | | −37 dBm(clock component, with 50 Ω load)<br>−70 dBm(non-clock component, with 50 Ω load) |
| **Internal Clock** | **Clock rate** | | 10m Hz to 10 MHz |
| | **Resolution** | | 10 mHz |
| | **Accuracy** | | ≦±50 ppm |
| | **Jitter** | | ≦800 ps rms (40 kHz to 10 MHz)<br>≦40 ppm rms of setting rate (10 mHz to 40 kHz)<br>(Phase detection bandwidth: 50 Hz to 15 kHz) |
| **Internal Memory** | **Waveform memory** | | 32000 words/channel (Max. 16 waveform types of from 10 words to 16000 words per waveform settable.) |
| | **Event memory** | | 32000 words (1 bit/word) |
| | **Sequence memory** | | 255 steps |
| **Function Generator Output** | **Output channels** | | Selectable among each channel |
| | **Method** | | Synthesizer method (Independent frequency and waveform selectable for each channel) |
| | **Output waveform** | | Sine, triangular, rectangular and ramp |
| | **Output frequency** | | 10 mHz to 2 MHz (sine waveform)<br>10 mHz to 200 kHz (other waveforms) } Resolution 10 mHz |
| | **Frequency accuracy** | | ≦±50 ppm (With frequency setting) |
| | **Jitter** | | ≦100 ns P-P |
| | **Phase between channels** | | Settable in 0.1 deg step (excludes 705110) |
| **Interface** | **GPIB** | | Conform to the IEEE St'd 488-1978<br>Interface codes: SH1, AH1, T6, L3, SR1, RL1, PP0, DC1, DT1, C1, C2, C3, C4, C27 |
| **General** | **Display** | | 9-inch CRT (amber) |
| | **Floppy disk** | | 3.5-inch 2DD |
| | **Power requirements** | | 90 to 250 V AC/48 to 63 Hz |
| | **Power consumption** | | 300 VA max |

[1] Common items for "arbitrary waveform output" and "function generator output".
[2] For FSATT accuracy, see DC accuracy in the Attenuator

| | | |
|---|---|---|
| **Digital Output (For 705142)** | **Output channels** | Selectable among from digital output (PG) or analog output (arbitrary or function generator) on channel 3 and 4. |
| | **Output bits** | (16 bits+STRB(clock)×1)/channel×2 |
| | **Waveforms** | Clock rate synchronous NRZ waveform |
| | **Output level** | CMOS level output (100 Ω serial termination) |
| | **Output current** | ≦10 mA/bit |
| | **Load resistance** | ≧1 kΩ |
| | **Inverse impressed voltage** | Within 0 to 5 V |

## AVAILABLE MODELS

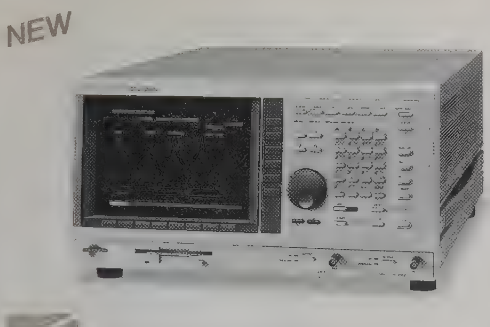
| Model | Suffix Codes | | | Description |
|---|---|---|---|---|
| **7051** | ··· | | ·················· | **AG1200** Arbitrary Waveform Generator Series |
| Function | **10** | | ·················· | **AG1200**<br>(1 channel, 1 analog output) |
| | **20** | | ·················· | **AG1200**<br>(2 channel, 2 analog output) |
| | **40** | | ·················· | **AG1200**<br>(4 channel, 4 analog output) |
| | **42** | | ·················· | **AG1200**(4 channel, 2 analog and 2 analog /digital output) |
| Power Requirements | | **-D** | ················ | 90 to 250 V AC |
| Power Cord | | **/D** | ········· | UL Standard |
| | | **/F** | ········· | VDE Standard |
| | | **/H** | ········· | SAA Standard |
| | | **/J** | ········· | BS Standard |
| | | **/M** | ········· | JIS Standard grounded cable * |
| 3-1/2" Floppy Disk Formatting Function | | | **/2DD** | 2DD, 720K B |

Note: * JIS standard grounded cable consists of UL standard power cord and 3-pin to 2-pin adapter

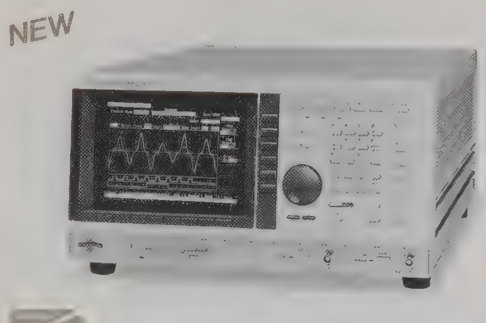
## OPTIONAL ACCESSORIES

| Name | Code | Order Q'ty |
|---|---|---|
| BNC cable (BNC-BNC, 1 m) | **366924** | 1 unit<br>(1 p[illegible]) |
| BNC cable (BNC-BNC, 2 m) | **366925** | |
| BNC cable (with alligator clip) | **366926** | |
| Interface cable for printer | **705931** | |
| BNC-banana terminal adapter | **366921** | |
| BNC (plug)-RCA (jack) adapter | **366927** | |
| BNC (jack)-RCA (plug) adapter | **366928** | |
| Digital output connector (36-pin) | **705940** | |
| Parallel connection kit for 2 units | **705922** | |
| Parallel connection kit for 3 units | **705923** | |
| Parallel connection kit for 4 units | **705924** | |
| Cleaning kit for CRT | **700921** | |

## AG2100A & AG2200 Arbitrary Waveform Generators 7050



**705032** 221×426×620 mm 25 kg



**705022** 221×426×620 mm 25 kg

The AG2000 Series can generate arbitrary waveforms up to the 100 MHz band (with the AG2200; up to the 50 MHz band with the AG2100A). The number of output channels is either 1 or 2 depending on the model. It is especially suitable for applications such as circuit evaluations of magnetic or optical disk devices, signal simulations in digital communications including the ISDN, evaluations of receiver circuits for radar/sonar/medical electronics, or evaluations of mixed analog and digital signal equipment.

**AG2100A. . .High resolution 10 bit, 100 MHz model; AG2200. . .High speed 8 bit, 200 MHz model**

The AG2000 Series can generate arbitrary waveforms on high speed, wide frequency bands.

**Stable and accurate simulation wave forms**

Low clock jitter with a maximum of 100 ps/rms (150 ps/rms for the AG2100A).

**Sequence programming with 128k words of waveform memory**

128k words of memory are available for generating arbitrary waveforms. Up to 16 waveforms can be created with the lengths set from 64 words to 8k words for the AG2200, or from 32 words to 8k words for the AG2100A. These waveform elements can be joined together and looped with Sequence Programming.

**A variety of functions for creating waveforms**

The AG2000 Series has three waveform-creation methods.

① **Mathematical formulas:** A waveform is defined with a time function y=f(t). Types of functions: SIN, COS, TAN, TAN$^{-1}$, EXP, LOG, Square root extraction (SQRT), absolute value (ABS), integer (INT), noise function, phase shift.

② **Scope draw:** Waveforms are freely created using the CRT screen as a canvas. The rotary knob is used to make a rough sketch of waveforms with dots and then interpolation is used between the dots. This can also be applied to modification of portions of a waveform.

③ **Actual waveforms:** Actual waveforms caught by digital oscilloscopes or other instruments are downloaded via a GPIB interface. Data transfer can be directly carried out by using YOKOGAWA's DL Series Data Transfer Function.

**Channel addition**

The output from CH1 and CH2 can be added in analog form and output.

### MAINFRAME SPECIFICATIONS

| Model | | AG2100A | AG2200 |
|---|---|---|---|
| Output | **Output channels** | One (**705031**), or two (**705032**) | One (**705021**), or two (**705022**) |
| | **DC accuracy** | <±(0.5% of setting+20 mV) (attenuator at 0 dB) | <±(1% of setting+40 mV) (attenuator at 0 dB) |
| | **Output impedance** | 50 Ω (nominal) | |
| | **Maximum output voltage** | 2 Vp-p (±1 V) (50 Ω load, attenuator at 0 dB)<br>4 Vp-p (±2 V) (CH1+CH2 summing mode, 50 Ω load, attenuator 0 dB) | |
| | **Output resolution** | 10 bits | 8 bits |
| | **Rise time** | <10 ns (10 to 90%, with filter OFF) | <5 ns (10 to 90%, with filter OFF) |
| | **Attenuator** | 0 dB to 63.5 dB (0.5 dB steps) | |
| | **Filter** | 2, 5, 10, 20 or 50 MHz selectable (overshoot ±5% of maximum swing, except when filter OFF and in CH1+CH2 summing mode) | 2, 5, 10, 20 50 or 100 MHz selectable (overshoot ±5% of maximum swing except when filter OFF and in CH1+CH2 summing mode) |
| Internal clock | **Clock rate** | 1 Hz to 100 MHz | 1 Hz to 200 MHz |
| | **Resolution** | 1 Hz | |
| | **Accuracy** | <±3 ppm | |
| | **Jitter** | <150 ps rms (phase detection bandwidth 50 Hz to 200 kHz) | <100 ps rms (phase detection bandwidth 50 Hz to 200 kHz) |
| Internal memory | **Waveform memory** | 128k words/channel (10 bits/word), up to 16 waveform types of up to 8k words per waveform settable | 128k words/channel (8 bits/word), up to 16 waveform types of up to 8k words per waveform settable |
| | **Event memory** | 128k words (2 bits/word), two event bits per waveform can be set for each word in waveform memory | |
| | **Sequence memory** | 682 steps/sequence program can be set up to 682 steps per sequence | |
| Auxiliary I/O | **External clock input** | 100 kHz to 100 MHz/0 to 10 dBm (AC coupling, input impedance 50 Ω) | 100 kHz to 200 MHz/0 to 10 dBm (AC coupling, input impedance 50 Ω) |
| | **External gate input** | TTL/ECL level selection (input impedance 10 kΩ) | |
| | **Event output** | 2 bits (ECL level, 50 Ω serial termination) | |
| | **Sync output** | 2 bits (TTL and ECL level, 50 Ω serial termination) | |
| | **Digital output (optional)** | 10 bits (ECL level/differential output), offset binary code, CH1 data only | 8 bits (ECL level/differential output), offset binary code, CH1 data only |
| Interface | **GPIB** | Conform to the IEEE St'd 488-1978 | |
| | **Printer output** | Connector Centronics | |
| General specifications | **Display** | 9-inch CRT (amber) | |
| | **Floppy disk** | 3.5-inch 2DD | |
| | **Power requirements** | 90 to 132 V AC or 180 to 250 V AC, 48 to 63 Hz | |
| | **Power consumption** | 500 VA max | |

### AVAILABLE MODELS

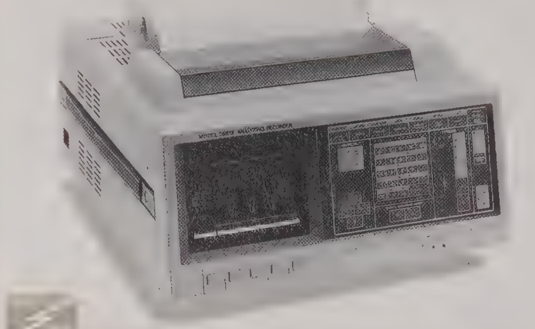
| Model | Suffix Codes | Description |
|---|---|---|
| **7050** | ··· | AG2000 Arbitrary Waveform Generator Series |
| Function | **31** | **AG2100A** (1 channel: 100 MHz, 10 bits) |
| | **32** | **AG2100A** (2 channel, 100 MHz, 10 bits) |
| | **21** | **AG2200** (1 channel: 200 MHz, 8 bits) |
| | **22** | **AG2200** (2 channel 200 MHz, 8 bits |
| Power Requirements | **1** | 90 to 132 V AC |
| | **5** | 180 to 250 V AC |
| Power Cord | **D** | UL Standard |
| | **F** | VDE Standard |
| | **H** | SAA Standard |
| | **J** | BS Standard |
| | **M** | JIS Standard grounded cable* |
| 3-1/2" Floppy Disk Formatting Function | **/2DD** | IBM format 2DD 720 kB |
| Optional Feature | **/DOUT** | Digital output |

Notes: * JIS standard grounded cable consists of UL standard power cord and 3-pin to 2-pin adapter

### OPTIONAL ACCESSORIES

| Name | Code | Order Q'ty |
|---|---|---|
| BNC cable (BNC-BNC, 1 m) | **366924** | 1 unit (1 pc./unit) |
| BNC cable (BNC-BNC, 2 m) | **366925** | |
| Interface cable for printer | **B9801KA** | |
| Cleaning kit for CRT | **700921** | |
| Carriage (Specialized carriage for DL and AG Series) | **700991** | |
| 50 Ω terminator | **366935** | |
| BNC Banana Terminal-Adapter | **366921** | |
| Banana Terminal-BNC Adapter | **366922** | |
| BNC-Alligator Clip Cable (1 m) | **366926** | |
| BNC (plug)-RCA (jack) Adapter | **366927** | |
| BNC (jack) RCA (plug) Adapter | **366928** | |

## Analyzing Recorder 3655E



**3655E** 4-channel model 236×400×499 mm 18 kg

A data logger, recorder, transient digitizer, FFT analyzer, and computing function are now available all in one: 3655E is a compact measuring system that analyzes, displays, and plots signals. It handles up to four input channels, and digitizes the signals at a rate of up to 50 kHz with 14-bit resolution. Based on all-in-one design concept, it includes an easy-to-read 7-inch CRT, four-color plotter, a variety of powerful computing functions in a single package.

**Simultaneous measurement, display, and plotting of up to 4 channels**

**Flexible plotting modes**

Real-Time and Memory modes.

**14-bit resolution A-D converter**

**8 K or 32 K words/channel of buffer memory**

**A variety of powerful computing functions**

Each channel or channel to channel; +, −, ×, ÷, square root, logarithm, exponential function, absolute value, 1st and 2nd differentials and integrals, and moving averages.

Measured waveforms; integral, max., min., pk-pk, mean and rms.

**Crisp, clean 4-color printout by built-in digital plotter**

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**Measuring Ranges:** ±60, 200, 600 mV, 2, 6, 20, 60 V F.S.

**Frequency Band (Analog Section):** DC to 20 kHz($^{+1}_{-3}$dB, DC coupling), 1 Hz to 20 kHz($^{+1}_{-3}$ dB, AC coupling), (DC to 1.5 Hz, −3 dB... real-time mode), at filter OFF.

**Input Coupling:** DC or AC (DC only in real-time mode).

**Type of Input:** Floating (unbalanced), isolated for each channel.

**Input Channels:** Up to 2 or 4.

**Accuracy:** ±0.25% of full scale on 2 V range, ±0.5% of full scale on other ranges, at filter OFF, DC, 23±3°C.

**TC Types & Measuring Ranges:** ANSI, JIS (or DIN) model...R(PtRh-pt); 0 to 1,600°C, K (NiCr-Ni); −200 to 1,300°C, E; −200 to 800°C, J(Fe-CuNi); −200 to 900°C, T(Cu-CuNi); −200 to 400°C.

**Resolution:** 14 bits.

**Conversion Speed:** 20 μs, A-D converter provided for each channel.

**Max. Memory Capacity for Each Channel:** 8K or 32K words

**Data Buffer Memory:** 500, 2K, 8K* words (**3655E□3**), or 500, 2K, 8K, 32K* words (**3655E□4**), *...not including computing or averaging operation

**Writing Rate:** 20 μs to 1 s/word (15 steps, 1-2-5 sequence), or external clock, parallel writing.

**Pre-Trigger:** 0 to 100% (10% steps).

**Trigger Modes:** FREE, RUN, REPEAT, SINGLE.

**Trigger Level:** −100 to +100% (internal, 2% steps), TTL-level (external)

**Averaging:** Linear or exponential averaging (number of averages or attenuation constant selectable from 4, 8, 16, 32, 64, 128, 256).

**Computing Functions:** +, −, ×, ÷, SQR (square root), LOG (logarithm), EXP (exponential function), ABS (absolute value), 1st & 2nd differentials, 1st & 2nd integrals, MEAN (100-point moving average), and Option Key modes.

**Option Key Modes:** Integral, max., min., pk-pk, mean, rms (within cursor range).

**Display Format:** Single, dual or X-Y mode.

**Zooming:** Vertical or horizontal axis.

**Plot Formats:** CRT copy, analog, digital or list.

**Duplex Plotting:** One or more waveforms can be plotted over the initial trace.

**Automatic Plot Start:** Plotting is automatically initiated by the trigger (at non-drying of pen tip).

**Chart Speed:** 4 cm/min to 1 cm/h (Real Time Mode)

**Display Tube:** 7″ CRT (amber)

**Plotter:** Four-color digital plotter using ball-point pens (black, red, green and blue).

**Power Requirements:** 90 to 132 V, or 180 to 250 V AC (must be specified), 48 to 63 Hz.

**Power Consumption:** 240 VA max.

### ■ FFT Module (365920A)

**Analyzing Functions:** Linear spectrum, power spectrum, power spectrum density, OVERALL, rms spectrum, cross spectrum, transfer function, and coherence function.

**Dynamic Range:** 72 dB (typical).

**Number of Channels:** 2 (any 2 channels on 4-channel model).

**Frequency Range:** 2 Hz to 20 kHz (13 steps, 1-2-5 sequence).

**Weighting:** Hanning or rectangular window.

**Anti-Aliasing Filter:** 50 Hz to 20 kHz (1-2-5 sequence), (50 Hz filter on 2 to 20 Hz ranges), OFF.

### ■ Data Memory Module (365910B)

**Memory Capacity:** Approx. 32K words.

**Data Storage:** Up to 16 files.

**Duplex Display:** Measured waveform and stored waveform in memory module are simultaneously displayed on CRT

### ■ AVAILABLE MODELS

| Model | Description | |
|---|---|---|
| **3655E 13** | 2 channels<br>(8K words/channel) | ANSI, JIS |
| **3655E 14** | 2 channels<br>(32K words/channel) | |
| **3655E 23** | 4 channels<br>(8K words/channel) | |
| **3655E 24** | 4 channels<br>(32K words/channel) | |
| **3655E 33** | 2 channels<br>(8K words/channel) | DIN |
| **3655E 34** | 2 channels<br>(32K words/channel) | |
| **3655E 43** | 4 channels<br>(8K words/channel) | |
| **3655E 44** | 4 channels<br>(32K words/channel) | |
| **/GP-IB** | GPIB interface | |
| **/RS232C** | RS-232-C interface | |

### ■ OPTIONAL MODULES

| Code | Name |
|---|---|
| **365910B** | Data memory module |
| **365920A** | FFT module (32K words) |

### ■ OPTIONAL ACCESSORIES

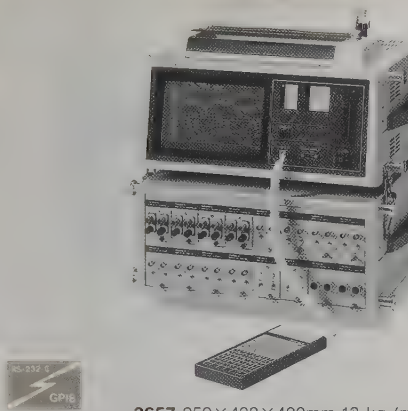
| Model | Name (Description) |
|---|---|
| **365961*** | Power unit (2 channels each for V&A) |
| **366921*** | Conversion adapter (BNC-banana) |
| **366922** | Conversion adapter (banana-BNC) |
| **366923*** | Plug adapter (T-shaped) |
| **366924*** | BNC cable (1 m) |
| **366925*** | BNC cable (2 m) |
| **366926*** | Clip lead |
| **B9409LA*** | Measurement lead (1 set) |

***Note:** Also usable for AR3200

### ■ SPARES

| Name | | Accessories supplied at no extra cost | Spares | |
|---|---|---|---|---|
| | | | Part No. | Order q'ty |
| Roll chart (20 m long) | | 1 roll | **B9708AR** | 6 units<br>(1 roll/unit) |
| Ball-point pen | Black | 1 pc. | **B9708QA** | 1 unit<br>(4 pcs./unit) |
| | Red | 1 pc. | **B9708QB** | 1 unit<br>(4 pcs./unit) |
| | Green | 1 pc. | **B9708QC** | 1 unit<br>(4 pcs./unit) |
| | Blue | 1 pc. | **B9708QD** | 1 unit<br>(4 pcs./unit) |

## AR3200 Analyzing Recorder 3657



**3657** 259×438×400mm 18 kg (mainframe)

The AR3200 is a multi-channel waveform measuring instrument, which measures, processes, displays and plots a variety of input signals of up to 32 channels. By incorporating large memory capacity of up to 10M bytes (approx. 4M words) and many powerful functions, AR3200 can be used for a diverse field of applications from laboratory to vehicle uses. By selecting from seven types of input modules, AR3200 can handle a variety of variables such as voltage, current, strain, temperature, vibration, displacement, pressure and sound level.

**Multi-channel measurements—Up to 16 or 32 channels**
**Selectable from 7 types of input modules**
**Large memory capacity—Up to 10M bytes (approx. 4M words)**
**Application software package increase advantages in use**
    Wave-Pack (Standard application package)
    FFT-Pack (Optional application package)
**14-bit resolution A-D converter**
**2 types of input units available**
    Input unit for 32 channels (installs 16 input modules) and 16 channels (installs 8 input modules) are available.
**AC or DC operation**
**A variety of powerful computing functions**

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### MAINFRAME

**Number of Input Channels:** Up to 16 (up to 8 input modules), or up to 32 (up to 16 input modules).
**A-D Converters:** Two groups (A, B)...16-channel model, four groups (A,B,C,D)...32-channel model.
**Resolution:** 14 bits.
**A-D Conversion Speed:** 20 $\mu$s.
**Maximum Memory Capacity (for All Channels):** 0.5M words (3657□1), 1M words (3657□2), 2M words (3657□3), 3M words (3657□4), 4M words (3657□5).
**Display Tube:** 120 × 192 mm electroluminescence (EL), amber 640×200 dots resolution.
**Plotter:** Four-color digital plotter using ball-point pens (black, red, green, blue...water ink).
**FDD:** 3.5″ high-density floppy disk drive.
**Storage of Measuring Conditions:** Up to eight conditions (Ni-Cd battery backup).
**Power Requirements:** 10 to 32 V DC, 90 to 132 V AC, or 180 to 250 V AC.
**Power Consumption:** 200 VA max. (with all optional features).

### INPUT MODULES

**DC Amplifier (365941)**
**Number of Input Channels:** 2.
**Measuring Ranges:** ±60, 200, 600 mV, 2, 6, 20 V full scale.
**Accuracy:** ±(0.2% of full scale + 50 $\mu$V).

**Strain Amplifier (365942)**
**Number of Input Channels:** 2.
**Measuring Ranges:** ±200, 600, 2,000, 6,000, or $20{,}000\times10^{-6}$ strains.
**Accuracy:** ±(0.5% of full scale + 2 $\mu$V).

**Charge Amplifier (365943)**
**Number of Input Channels:** 2.
**Measuring Ranges:** ±2, 20, 200, 2,000 G (1 to 10 pC/G), ±0.2, 2, 20, 200 G (10 to 100 pC/G).
**Accuracy:** ±2% of full scale.

**Isolation Amplifier (365944)**
**Number of Input Channels:** 2.
**Measuring Ranges:** ±60, 200, 600 mV, 2, 6, 20 V full scale.
**Accuracy:** ±(0.3 of full scale+50 $\mu$V).

**F-V Converter (365945A)**
**Number of Input Channels:** 2.
**Measuring Ranges:** 60 to 1,000 rpm, 60 to 10,000 rpm.
**Accuracy:** ±0.3 % of full scale.

**TC Converter (365946)**
**Number of Input Channels:** 2.
**TC Type:** K and T (ANSI, JIS).
**Measuring Ranges:** Type K...0 to 1,200°C, Type T...−50 to +200°C.
**Accuracy:** ±(0.3% of full scale+3°C).

**TC Converter (365947)**
**Number of Input Channels:** 2
**TC Type:** J and R (ANSI, JIS).
**Measuring Ranges:** Type J...0 to 800°C, Type R...0 to 1,600°C.
**Accuracy:** Type J...±(0.3% of full scale+3°C).

### ▨ WAVE-Pack (Standard)

**Measuring Modes:** Normal mode, repeat mode and monitor mode
**Memory Setting:** Setting by measuring time, or setting by memory capacity.
**Memory Writing Speed Designation:** 50, 25, 10, 5, 2.5, 1 kHz, 500, 250, 100, 50, 25, 10, 5, 2.5, or 1 Hz (for each group).
**Maximum Memory Writing Speed (For Each A-D Conversion Group):** 50 kHz (for 1 channel), 25 kHz (for 2 channels), 10 kHz (for 4 channels), 5 kHz (for 8 channels)
**Computing Operational Modes:** +, −, ×, ÷, SQR (square root), LOG (logarithm), EXP (exponential function), ABS (absolute value), 1st & 2nd differentials, 1st & 2nd integrals, MEAN (100-point moving average), and function key modes.
    Data computation between channels or functional computation for each channel.
**Function Key Modes:** Integral, max., min., pk-pk, mean, rms.
**Display Formats:** Single, dual, quadruple, X-Y
**Plotting Size:** A4, A5 (copy mode), or continuous (analog or digital mode).

### ▨ FFT-Pack (Optional, use with /DSP)

**Analyzing:** Linear spectrum, power spectrum, power spectrum density, rms spectrum, cross spectrum, transfer function, and coherence function.
**Number of Channels:** Up to 8.
**Frequency Ranges:** 0.4, 1, 2, 4, 10, 20, 40, 100, 400 Hz, 1, 2, 4, 10, 20 kHz.
**Data Sampling:** 512, 1,024, 2,048 points.
**Weighting:** Hanning or rectangular window.
**Averaging Modes:** Linear sum (stable), or exponential averaging for time and frequency domain (number of averages...2, 4, 8, 16, 32, 64, 128 or 256 times, preselectable).

### AVAILABLE MODELS

| Model | Suffix Codes | | | Memory Size | Power Requirements | No. of Channels |
|---|---|---|---|---|---|---|
| **3657** | **11** | **-B** | | 2M bytes | DC | Up to 16 |
| | **12** | | | 4M bytes | | |
| | **13** | | | 6M bytes | | |
| | **14** | | | 8M bytes | | |
| | **15** | | | 10M bytes | | |
| | **21** | **-B** | | 2M bytes | DC | Up to 32 |
| | **22** | | | 4M bytes | | |
| | **23** | | | 6M bytes | | |
| | **24** | | | 8M bytes | | |
| | **25** | | | 10M bytes | | |
| | **31** | **-1 or -5** | | 2M bytes | AC | Up to 16 |
| | **32** | | | 4M bytes | | |
| | **33** | | | 6M bytes | | |
| | **34** | | | 8M bytes | | |
| | **35** | | | 10M bytes | | |
| | **41** | **-1 or -5** | | 2M bytes | AC | Up to 32 |
| | **42** | | | 4M bytes | | |
| | **43** | | | 6M bytes | | |
| | **44** | | | 8M bytes | | |
| | **45** | | | 10M bytes | | |
| Power Requirements | | **-B** | | 10 to 32 V DC | | For 365711~25 |
| | | **-1** | | 90 to 132 V AC | | For 365731~45 |
| | | **-5** | | 180 to 250 V AC | | |
| Optional Features | | | **/REM** | Remote display (including /EXT) | | |
| | | | **/EXT** | External interrupt | | |
| | | | **/DSP** | Digital signal processing | | |
| | | | **/GP-IB** | GPIB interface | | |
| | | | **/RS232C** | RS-232 C interface | | |

Notes 1 Both **GPIB** and **RS-232-C** interfaces are not compatible with a single unit
2 **/DSP** must be specified when using FFT Pack

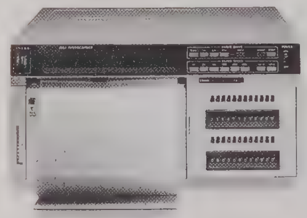
### INPUT MODULES (OPTIONAL)

| Model | Name | Description |
|---|---|---|
| **365941** | DC amplifier | 2 channels (±60 mV to 20 V) |
| **365942** | Strain amplifier | 2 channels (±200 to 20,000×$\mu$strains) |
| **365943** | Charge amplifier | 2 channels (0.2 to 200 G) |
| **365944** | Isolation amplifier | 2 channels (±60 mV to 20 V) |
| **365945A** | F-V converter | 2 channels (60 to 10,000 rpm) |
| **365946** | TC converter | 2 channels (JIS, ANSI K, T) |
| **365947** | TC converter | 2 channels (JIS, ANSI J, R |

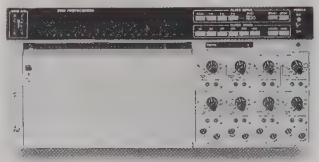
### OPTIONAL ACCESSORIES

| Code | Name | Description |
|---|---|---|
| **365960** | AC adapter | AC power supply (90 to 132/180 to 250 V AC switch selectable. |
| **365988** | Full keyboard | For AR3200 |
| **365996** | Blank panel | For panel space of a single input module |
| **365997** | DC power cord | For DC operation |
| **319300** | Bridge head | For 365942 |

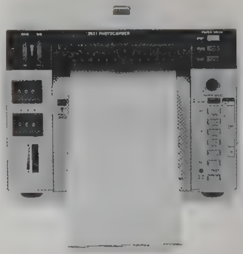
## 2931/2932 Photocorders



**29323□** 200×430×440 mm 23.5 kg



**29324□** 200×430×440 mm 25 kg



**2931** 199×280×409 mm 15 kg

Exceptionally compact 6-, 8-, 9-, 18-, or 24-channel oscillographs, providing portability, reliability and simple operation. The galvanometers are easily installed without vertical adjustment. Trace identification is available for 18- and 24-channel models in the form of a sequential interruption on all traces. Using versatile remote control functions, you can determine chart drive START/STOP, and control timing line intervals with an external signal. 8-channel model contains DC amplifiers which provide expanded-scale traces.

**Stable chart drive and quiet operation by DC servo mechanism**
**Chart speeds from 10 cm/min to 200 cm/s (2931), or to 400 cm/s (2932)**
**No vertical adjustment of galvanometer light spot**

**PAPER SHOT button to select preset record length of 0.5 to 4 m (stepless)**
**A wide range of remote controls**

---

**Optical Arm:** 330 mm.
**Chart:** 2931...127 mm wide Z-fold or roll chart, 2932...178 mm wide Z-fold chart (152 or 203 mm wide Z-fold chart also usable...to be furnished by user).
**Chart Speeds:** 2931...10 cm/min to 200 cm/s (10 speeds), 2932...10 cm/min to 400 cm/s (12 speeds).
**Paper Shot:** 0.5 to 4 m (stepless).
**Input Signal Multipliers:** 0 to 455 kΩ in 10 steps for each channel.
**Grid Lines and Timing Lines:** Automatically marked.
**Trace Identification and Numbering:** Provided with 18- and 24-channel models.
**Remote Controls (Standard):** Chart drive START/STOP, timing line intervals, remote operation of up to 10 units, *chart speeds, and *timing synchronization (*2931 only).

### AVAILABLE MODELS

| Number of channels | Model | |
|---|---|---|
| | 50 Hz | 60 Hz |
| 6 | 293100 | 293100 |
| 9 | 293211 | 293212 |
| 18 | 293221 | 293222 |
| 24 | 293231 | 293232 |
| 8 (DC amplifiers self-contained type) | 293241 | 293242 |

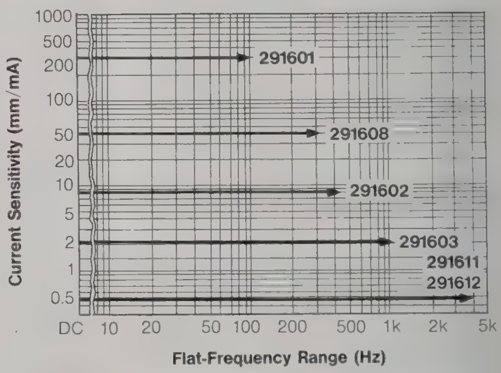
### SPARES FOR PHOTOCORDERS

| Part No. | Name and Description | | Photocorder Model |
|---|---|---|---|
| B9496BB | Recording Paper | KODAK Roll paper (127 mm×45.7 m) | 2931 |
| B9496BE | | ORIENTAL Roll Paper (127 mm×35 m) | |
| B9464AF | | ORIENTAL Z-fold Paper (127 mm×30 m) | |
| B9464AG | | ORIENTAL Z-fold Paper (127 mm×60 m) | |
| B9496GB | Recording Paper | ORIENTAL Z-fold Paper (178 mm×60 m) | 2932 |
| B9496GD | | ORIENTAL Z-fold Paper (178 mm×30 m) | |
| A9052EH | Mercury Vapour Lamp | USHIO | 2931, 2932 |
| A9071EH | | OSRAM | |
| A9036EH | USHIO Timing Lamp | | 2931, 2932 |

## 2916 Galvanometers for 2931 & 2932

Galvanometer (Actual Size)

Particular attention should be paid to frequency characteristics, since sensitivity can be amplified by an external amplifier, while frequency response is determined only by the characteristics of the galvanometer itself.



### AVAILABLE MODELS

| Model | Natural Frequency (Hz) | Flat (5%) Frequency Range (Hz) | Coil Resistance (Ω) | External Damping Resistance (Ω) | Sensitivity (Optical Arm: 330 mm) (μA/mm) | Maximum Safe Current (mA) |
|---|---|---|---|---|---|---|
| 291601 | 170 | 100 | 22 | 17 | Approx. 4.5 | 1 |
| 291602 | 1,000 | 400 | 27 | Oil damped | Approx. 160 | 50 |
| 291603 | 2,500 | 1,000 | 27 | Oil damped | Approx. 630 | 100 |
| 291608 | 600 | 300 | 30 | Oil damped | Approx. 34 | 10 |
| 291611 | 4,000 | 2,000 | 30 | Oil damped | Approx. 1,400 | 100 |
| 291612 | 7,000 | 3,500 | 30 | Oil damped | Approx. 3,800 | 100 |

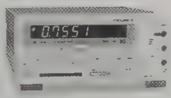
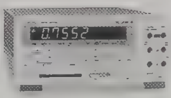
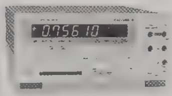
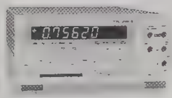
The 7561 and 7562 are high performance digital multimeters with excellent stability, high-speed and noise immunity. These multimeters make use of YOKOGAWA-original A-D converter system.

A GPIB or RS-232-C communication interface is provided as standard model. The multimeter incorporates a memory unit which can store 1,000 measured data and buffer data for system use. Furthermore, an IC memory card (optional) is available for storing measured data and setting a 20-step program for changing measurement functions and ranges.

### PWM A-D CONVERTER

YOKOGAWA's proven feedback pulse width modulation (PWM) A-D converter features high noise immunity, high accuracy, excellent stability and linearity, and provides reliable measurements.

### SELECTION GUIDE

| | | | | | | |
|---|---|---|---|---|---|---|
| | |  |  |  |  | |
| **Model** | | 7551 | 7552 | 7561 | 7562 | 2501A |
| **No. of Digits** | | 5-1/2 | 5-1/2 | 6-1/2 | 6-1/2 | 6-1/2 |
| **Maximum Reading** | | 199999 | 199999 | 1999999 | 1999999 | 1199999 |
| **DC Voltage** | **Accuracy** | 0.005%+ 3 digits | 0.005%+ 3 digits | 0.003%+15 digits | 0.003%+15 digits | 0.005%+5 digits |
| | **Range** | 1,000 V | 1,000 V | 1,000 V | 1,000 V | 1,000 V |
| | **Resolution** | 1 μV | 1 μV | 0.1 μV | 0.1 μV | 0.01 μV |
| **AC Voltage** | **Accuracy** | 0.3%+100 digits | 0.3%+100 digits | — | 0.15%+100 digits | 0.07% of rdg +0.03% of range |
| | **Range** | 700 V | 700 V | — | 700 V | 500 V |
| | **Resolution** | 1 μV | 1 μV | — | 1 μV | 1 μV |
| **DC Current AC Current** | **Range** | 2 A | 20 A | 2 A (DC current only) | 2 A | |
| | **Resolution** | 0.01 μA | 0.01 μA | 0.01 μA (DC current only) | 0.01 μA | — |
| **Resistance** | **Range** | 200 MΩ | 200 MΩ | 200 MΩ | 200 MΩ | 100 MΩ |
| | **Resolution** | 1 mΩ | 1 mΩ | 0.1 mΩ | 0.1 mΩ | 0.1 mΩ |
| **Display (LED)** | | ○ | ○ | ○ | ○ | ○ |
| **Frequency** | | — | ○ | — | — | |
| **Relative** | | ○ | ○ | ○ | ○ | ○ |
| **Comparator** | | ○ | ○ | ○ | ○ | ○ |
| **Data Hold** | | ○ | ○ | ○ | ○ | ○ |
| **Range Hold** | | ○ | ○ | ○ | ○ | ○ |
| **Memory** | | ○ | ○ | ○ | ○ | |
| **GPIB** | | ○ | ○ | ○ | ○ | ○ |
| **RS-232-C** | | ○ | ○ | ○ | | |
| **Power Requirements** | | 100 or 115, 200 or 230 V AC | | 100 or 115, 200 or 230 V AC | | 100, 120, 200, 220 or 240 V AC |

Note: ○...Available

### LONG TERM STABILITY

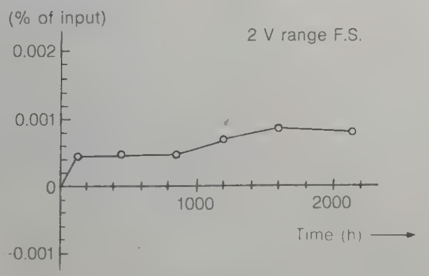


Fig. 1 (7562)

### LINEARITY

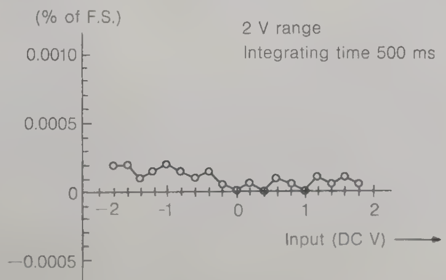
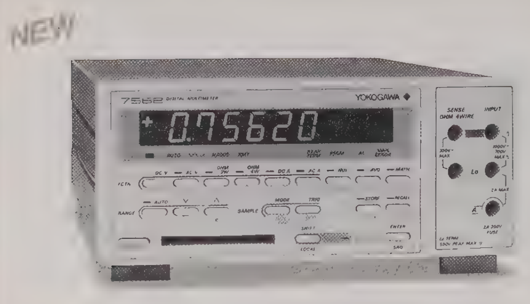
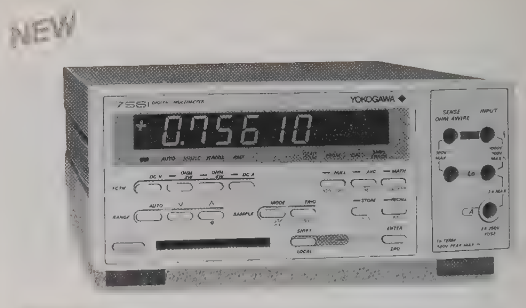


Fig. 2 (7562)

# Digital Multimeters 7551 & 7552 · 7561 & 7562



**7562** 88×213×300 mm 3 kg
(6-1/2 digits)



**7561** 88×213×300 mm 3 kg
(6-1/2 digits)

The 7550 (5-1/2 digit display) and 7560 (6-1/2 digit display) Series is a high-accuracy, high-speed sampling digital multimeter lineup using a YOKOGAWA original A-D converter, which features excellent stability, high noise immunity and linearity. In addition to the basic features, 'an optional IC memory card capable of storing 8,000 data, GPIB or RS-232-C interface and versatile measurement functions allow these multimeters to be used in diverse fields of applications, from bench to system uses.

**High accuracy, and excellent stability and linearity**

7550 Series: DC voltage accuracy: ±0.005% of rdg±3 digits

7560 Series: DC voltage accuracy: ±0.003% of rdg±15 digits

**High-speed sampling**

7550 Series: 125 times/s

7560 Series: 333 times/s

**A large memory capacity of 8,000 data by using IC memory card (optional)**

The 7550 and 7560 Series can store 1,000 measured data by using internal memory (or 8,000 data by using an optional IC memory card).These storage functions allow DMM's to be used as high-speed data logger.

**IC memory card allows you to:**

- Save up to 8,000 measured data.
- Functions, ranges, and mathematical functions ON/OFF, and sample speed and so on, are saved.
- Setting programs using the front panel keys and measured data can be stored.
- Automatic loading of setting program at power ON.

7550 and 7560 Series get the more applications by the above IC memory card functions.

The data format of IC memory card is compatible with that of YOKOGAWA LR Series and HR Series Recorders, so the measured data can be recorded in analog form on strip chart.

**An input-site change between front and rear panels (7560 series)**

The 7560 Series comes with voltage and resistance measurement terminals on both the front and rear panels. This allows the use of the multimeters whether mounted on a bench or on a rack.

**GPIB or RS-232-C interface (standard)**

**Versatile mathematical functions**

Null, averaging, scaling, decibel and comparator.

**Calibration function**

The multimeters can be calibrated either by front panel key operations or via communication interfaces. The multimeters are calibrated without opening the case and any special calibration skills.

**Operating Principle:** Feedback pulse width modulation method.
**Sample Mode:** Auto/Single/N reading.
**Sampling Interval:** 8 ms to 60 min (7551 and 7552), 3 ms to 60 min (7561 and 7562), (1 ms min., 1 s at 3 s or more).
**Maximum Reading:** 199999 (7551 and 7552), 1999999 (7561 and 7562).
**Overrange Information:** —oL— sign display.
**Data Memory:** 1000 data, measured data can be stored and recalled: (STORE/RECALL).
**Ranging:** AUTO, MANUAL, (remote control and programming possible).
**Warmup Time:** Approx. 60 minutes to rated accuracy.
**Power Requirements:** 100 or 115, 200 or 230 V AC (must be specified) , 50 or 60 Hz.
**Power Consumption:** 20 VA max.

## SELECTION GUIDE

### 7551

DC V · DC A · OHM-2W · AC Vmean
AC Amean · SAMPLE 125 · MATH · MEMO 1000
IC Card · GPIB · RS-232-C

**5-1/2 digits, Max display: 199999**
**DC V accuracy, ±0.005%**

### 7552

DC V · DC A · OHM-2W · OHM-4W
AC Vrms · AC Arms · freq · 20A
SAMPLE 125 · MATH · MEMO 1000 · IC Card
GPIB · RS-232-C

**5-1/2 digits, Max display: 199999**
**DC V accuracy: ±0.005%**

### 7561

DC V · DC A · OHM-2W · OHM-4W
SAMPLE 333 · MATH · MEMO 1000 · IC Card
F/R · GPIB · RS-232-C

**6-1/2 digits, Max. display: 1999999**
**DC V accuracy: ±0.003%**

### 7562

DC V · DC A · OHM-2W · OHM-4W
AC Vrms · AC Arms · SAMPLE 333 · MATH
MEMO 1000 · IC Card · F/R · GPIB
RS-232-C

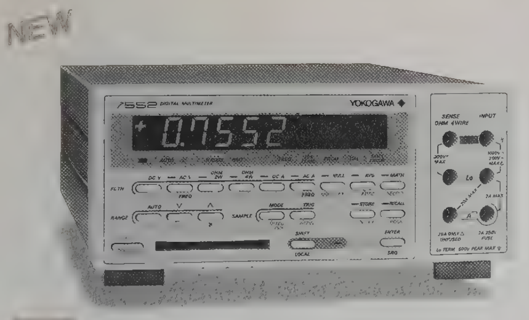
**6-1/2 digits, Max. display: 1999999**
**DC V accuracy: ±0.003%**

## SELECTION SYMBOLS

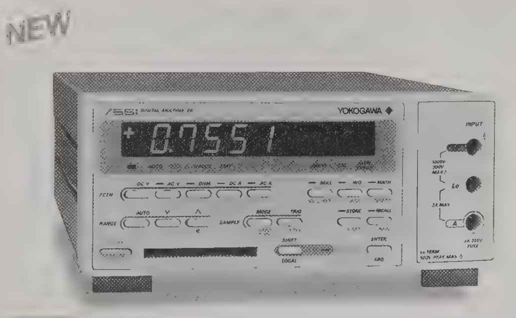
The symbols below describe the functions of the 7550/7560 Series multimeters. Select the ideal one from our powerful lineup of 4 models.

| | |
|---|---|
| DC V | DC Voltage |
| DC A | DC Current |
| OHM-2W | OHM 2-wire |
| OHM-4W | OHM 4-wire |
| AC Vmean | AC Voltage mean |
| AC Amean | AC Current mean |
| AC Vrms | AC Voltage rms |
| AC Arms | AC Current rms |
| freq | Frequency |
| 20A | 20 A Current |
| SAMPLE 333 | Sampling rate (333 times/s) |
| MATH | Mathematical function |
| MEMO 1000 | Internal memory (1,000 data) |
| IC Card | IC memory card (8,000 data) |
| F/R | Input-site change between front and rear panels |
| GPIB | GPIB Interface |
| RS-232-C | RS-232-C Interface |

# Digital Multimeters 7551 & 7552 · 7561 & 7562



**7552** 88×213×300 mm 3 kg
(5-1/2 digits)



**7551** 88×213×300 mm 3 kg
(5-1/2 digits)

## 7551 & 7552 (5-1/2 DIGITS)

### DC VOLTAGE (DC V): ±(% of rdg+digits)

| Range | Accuracy (90 days, 23±5°C) | Resolution |
|---|---|---|
| 200 mV | 0.008+8 | 1 μV |
| 2,000 mV | 0.005+3 | 10 μV |
| 20 V | 0.012+4 | 100 μV |
| 200 V | 0.011+3 | 1 mV |
| 1,000 V | 0.013+3 | 10 mV |

### DC CURRENT (DC A): ±(% of rdg+digits)

| Range | Accuracy (1 year, 23±5°C) | Resolution |
|---|---|---|
| 2 mA | 0.07+100 | 10 nA |
| 20 mA | 0.07+20 | 100 nA |
| 200 mA | 0.07+20 | 1 μA |
| 2,000 mA | 0.15+40 | 10 μA |
| 20 A(7552 only) | 0.4 +200 | 100 μA |

### RESISTANCE (OHM): ±(% of rdg+digits)

| Range | Accuracy (90 days, 23±5°C) | Resolution |
|---|---|---|
| 200 Ω | 0.014+7 | 1 mΩ |
| 2,000 Ω | 0.011+6 | 10 mΩ |
| 20 kΩ | 0.011+5 | 100 mΩ |
| 200 kΩ | 0.012+5 | 1 Ω |
| 2,000 kΩ | 0.05 +20 | 10 Ω |
| 20 MΩ | 0.25 +30 | 100 Ω |
| 200 MΩ | 2 +200 | 1 kΩ |

### AC VOLTAGE (AC V): ±(% of rdg+digits)

| Range | Accuracy (43 to 10 kHz) (1 year, 23±5°C) | Resolution |
|---|---|---|
| 200 mV | 0.4+200 | 1 μV |
| 2,000 mV | 0.2+100 | 10 μV |
| 20 V | 0.2+100 | 100 μV |
| 200 V | 0.3+100 | 1 mV |
| 700 V | 0.4+100 | 10 mV |

### AC CURRENT(AC A): ±(% of rdg+digits)

| Range | Accuracy (40 to 10 kHz) (1 year, 23±5°C) | Resolution |
|---|---|---|
| 2 mA | 0.5+300 | 10 nA |
| 20 mA | 0.5+200 | 100 nA |
| 200 mA | 0.5+200 | 1 μA |
| 2,000 mA | 1.0+200 | 10 μA |
| 20 A(7552 only) | 1.2+300 | 100 μA |

### FREQUENCY (FREQ) (7552 only)

| Range | Frequency Range and Display |
|---|---|
| 200 Hz | 20.000 to 199.999 Hz |
| 2,000 Hz | 180.00 to 1,999.99 Hz |
| 20 kHz | 1.8000 to 19.9999 kHz |
| 200 kHz | 18.000 to 199.999 kHz |

**Fundamental Frequency Accuracy:** ± 100ppm.

## 7561 & 7562 (6-1/2 DIGITS)

### DC VOLTAGE (DC V): ±(% of rdg+digits)

| Range | Accuracy (90 days, 23±5°C) | Resolution |
|---|---|---|
| 200 mV | 0.005+40 | 0.1 μV |
| 2,000 mV | 0.003+15 | 1 μV |
| 20 V | 0.004+15 | 10 μV |
| 200 V | 0.008+15 | 100 μV |
| 1,000 V | 0.009+20 | 1 mV |

### DC CURRENT (DC A): ±(% of rdg+digits)

| Range | Accuracy (1 year, 23±5°C) | Resolution |
|---|---|---|
| 2 mA | 0.05+100 | 10 nA |
| 20 mA | 0.05+20 | 100 nA |
| 200 mA | 0.05+20 | 1 μA |
| 2,000 mA | 0.1 +40 | 10 μA |

### RESISTANCE (OHM): ±(% of rdg+digits)

| Range | Accuracy (90 days, 23±5°C) | Resolution |
|---|---|---|
| 200 Ω | 0.011+50 | 0.1 mΩ |
| 2,000 Ω | 0.009+35 | 1 mΩ |
| 20 kΩ | 0.009+30 | 10 mΩ |
| 200 kΩ | 0.01 +30 | 100 mΩ |
| 2,000 kΩ | 0.03 +150 | 1 Ω |
| 20 MΩ | 0.2 +30 | 100 Ω |
| 200 MΩ | 2 +200 | 1 kΩ |

### *AC VOLTAGE (AC V): ±(% of rdg+digits)

| Range | Accuracy (43 to 10 kHz) (1 year, 23±5°C) | Resolution |
|---|---|---|
| 200 mV | 0.3 +200 | 1 μV |
| 2,000 mV | 0.15+100 | 10 μV |
| 20 V | 0.15+100 | 100 μV |
| 200 V | 0.3 +100 | 1 mV |
| 700 V | 0.3 +100 | 10 mV |

### *AC CURRENT (AC A): ±(% of rdg+digits)

| Range | Accuracy (43 to 10 kHz) (1 year, 23±5°C) | Resolution |
|---|---|---|
| 2 mA | 0.5+250 | 10 nA |
| 20 mA | 0.5+200 | 100 nA |
| 200 mA | 0.5+200 | 1 μA |
| 2,000 mA | 1.0+200 | 10 μA |

***Note:** 7562 only.

## AVAILABLE MODELS

| Model | Suffix Codes | | | Description | |
|---|---|---|---|---|---|
| 755101 | ········· | | ············ | 5.5 digits | DC V, DC A, OHM<br>AC V, AC A, (GPIB) |
| 755102 | ········· | | ············ | | DC V, DC A, OHM,<br>AC V, AC A, (RS-232-C) |
| 755201 | ········· | | ············ | | DC V, DC A, f, OHM<br>AC V, AC A, (GPIB) |
| 755202 | ········· | | ············ | | DC V, DC A, f, OHM,<br>AC V, AC A, (RS-232-C) |
| 756101 | ········· | | ············ | 6.5 digits | DC V, DC A, OHM<br>(GPIB) |
| 756102 | ········· | | ············ | | DC V, DC A, OHM<br>(RS-232-C) |
| 756201 | ········· | | ············ | | DC V, DC A, OHM,<br>AC V, AC A, (GPIB) |
| 756202 | ········· | | ············ | | DC V, DC A, OHM,<br>AC V, AC A, (RS-232-C) |
| | -B | ··· | ············ | Always B | |
| Power Requirements | | -1 | ············ | 100 V AC (50 or 60 Hz) | |
| | | -3 | ············ | 115 V AC (50 or 60 Hz) | |
| | | -5 | ············ | 200 V AC (50 or 60 Hz) | |
| | | -7 | ············ | 230 V AC (50 or 60 Hz) | |
| Power Cord | | | /B ······ | JIS standard | |
| | | | /D ······ | UL standard | |
| | | | /F ······ | VDE standard | |
| | | | /G ······ | SAA standard | |
| Optional Feature | | | /DA | D-A converter output | |

## OPTIONAL ACCESSORIES

| Name | Code | Description | Order Q'ty |
|---|---|---|---|
| Memory card (8K bytes) | 378901 | Setting & measured data | 1 unit (1pc./unit) |
| Memory card (16K bytes) | 378902 | Setting & measured data | |
| Memory card (64K bytes) | 378903 | Setting & measured data | |
| Dummy card | B9586NG | Dust cap for memory card slot | 2 units (1pc./unit) |
| Shielded test leads | B9409LA | Alligator type 0.8 m | 1 unit (1pc./unit) |
| Rack mounting kit | 751501<br>751502<br>751503<br>751504 | EIA (single mounting)<br>EIA (double mounting)<br>JIS (single mounting)<br>JIS (double mounting) | |
| 4-wire resistance measuring lead | 751510 | 0.6 m | |
| Input terminal adapter | 751512 | – | |
| 20 A measuring lead | 751513 | 0.8 m | |

**Standard Accessories:** Power supply cord, measuring lead, remote connector, fuse and instruction manual

## SAMPLING INTERVAL (COMMON TO 7550/7560 SERIES)

| Integrating Time | Measurement Intervals (in AUTO Zero OFF) | Measurement Intervals (in AUTO Zero ON) | Notes |
|---|---|---|---|
| 1.2 ms* | 3 ms (333/s) | 7 ms (143/s) | ●*7560 Series only<br>●Sampling mode is AUTO, NULL; off, AVG: off MATH: off, function: DC V in a fixed range, without communication function, using buffer memory<br>●Data of sampling interval shows min. value (fastest sample rate). Measurement intervals can be settable more than the value of left table |
| 2.5 ms | 8 ms (125/s) | 15 ms (66.7/s) | |
| 16.7 ms | 25 ms (40/s) | 45 ms (22.2/s) | |
| 20 ms | 30 ms (33.3/s) | 55 ms (18.2/s) | |
| 100 ms | 110 ms (9.1/s) | 215 ms (4.7/s) | |
| 200 ms* | 210 ms (4.8/s) | 415 ms (2.4/s) | |
| 500 ms* | 510 ms (2/s) | 1015 ms (1/s) | |

## 2501A Precision Digital Multimeter

**2501A23** 110×440×410 mm 10.5 kg

The 2501A is a high-performance 6-1/2-digit digital multimeter using a high-speed pulse width modulation technique (integrating type) of excellent noise immunity. It provides top-grade accuracy of 50 ppm (DC V), sensitivity of 0.1 μV DC, and resolution of 0.1 mΩ. The 2501A accommodates four measurement functions of DC mV, DC V, AC V (true rms) and Ω with the convenient five programmable calculating functions.

**Top-grade accuracy (50 ppm, DC V) and sensitivity (0.1 μV DC)**
**5-1/2-digit (high speed)/6-1/2-digit (high resolution) display selectable at the push of a button**

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**Operating Principle:** High-speed feedback pulse width modulation counting method (integrating type).
**Display:** 7-segment red LED.
**Maximum Reading:** 1199999 (6-1/2-digit) or 119999 (5-1/2-digit).
**Ranging:** Automatic or manual (remote control possible).
**Unit Marks:** mV, V, Ω, kΩ, MΩ, %.
**Overrange Information:** —OL—display.
**Sample Rate:** Approx. 3 times/s (5-1/2-digit), 2 times/s (6-1/2-digit) or HOLD (remote control possible).
**Operating Temperature Range:** 5 to 40°C (41 to 104°F).
**Humidity Range:** Up to 80% relative humidity.
**Warm-up Time:** Approx. 60 minutes.
**Dielectric Strength:** 1,500 V AC for one minute between power line and case
**Insulation Resistance:** More than 100 MΩ at 500 V DC between power line and case.
**Power Requirements:** 100, 120, 200, 220 or 240 V AC (must be specified), 50 and 60 Hz.
**Power Consumption:** Approx. 50 VA (2501A23)

### DC MILLIVOLT

**Ranges:** ±10 mV, ±100 mV, ±1 V, ±10 V.
**Overrange:** Approx. 20% on all ranges.
**Sensitivity:** 0.1 μV on 10 mV range (5-1/2-digit).
**Accuracy:** 24 hours, 23±1°C,
*10 mV range··········±[0.005% of rdg+ 2 (**20) digits],
*100 mV range········±[0.003% of rdg+ 1 (5) digit(s)],
1 & 10 V ranges ······±[0.002% of rdg+ 1 (3) digit(s)]

### DC VOLTAGE

**Ranges:** ±100 mV, ±1 V, ±10 V, ±100 V, ±1,000 V
**Overrange:** Approx. 20% on all except 1,000 V range.
**Sensitivity:** 1 μV on 100 mV range (5-1/2-digit)
**Accuracy:** 24 hours, 23±1°C,
*100 mV range········±[0.003% of rdg+ 1(**10)digit(s)],
1 to 1,000 V ranges ····±[0.002% of rdg+ 1 (3) digit(s)].

### RESISTANCE

**Ranges:** 100 Ω, 1 kΩ, 10 kΩ, 100 kΩ, 1,000 kΩ, 10 MΩ, 100 MΩ.
**Overrange:** Approx. 20% on all ranges.
**Sensitivity:** 1 mΩ on 100 Ω range (5-1/2-digit).
**Accuracy:** 24 hours, 23±1°C,
100 Ω range ············±[0.003% of rdg +2 (20) digits],
1 to 100 kΩ ranges ······±[0.002% of rdg +1 (3) digit (s)],
1 MΩ range ············±[0.003% of rdg +1 (3) digit(s)],
10 MΩ range ············±[0.01% of rdg +1 (6) digit(s)],
100MΩ range ············±[0.1% of rdg +1 (6) digit(s)].

( ) ····6-1/2 digit display.
*····after zero adjustment.
**····10 digits for 10-time averaging.

### AC VOLTAGE (True rms)...2501A21 & 2501A23

**Ranges:** 1 V, 10 V, 100 V, 500 V.
**Overrange:** Approx. 20% on all ranges.
**Sensitivity:** 1 μV on 1 V range (5-1/2-digit).
**Accuracy:** 24 hours, 23±1°C,
50 to 500 Hz range: ±(0.05% of rdg+0.02% of range),
40 Hz to 20 kHz range: ±(0.1% of rdg+ 0.05% of range),
20 to 100 kHz range: ±(0.5% of rdg+0.2% of range).

### AVAILABLE MODELS

| Model | Functions |
|---|---|
| **2501A20** | DC voltage and resistance |
| **2501A21** | DC voltage, resistance and AC voltage |
| **2501A22** | DC voltage and resistance (with analog output) |
| **2501A23** | DC voltage, resistance and AC voltage (with analog output) |

## 2543 Portable Printer

**2543** 60×166×207 mm 1.1 kg

Compact, stand-alone unit that accepts DC voltage, and provides a permanent record of digital data. The 2543 includes an A-D converter, thermal printer and quartz clock.

**Max. resolution...10 μV**
**Scaling of input from 1 to approx. 10 times**
**Decimal point and engineering units setting**
**Print interval selector**
**Battery/power line operation**

**Input:** 0 to ±20 V DC (up to 100 V peak).
**Range Selector:** 0.02, 0.2, 2 and 20 V DC.
**Accuracy:** ±(0.015% of rdg + 0.1% of range)
**Input Impedance:** Approx. 1 MΩ.
**Engineering Units:** Any two of the following 16 symbols can be combined (space, V, A, W, Ω, S, %, 1×, C, F, H, P, M, k, m, μ).
**Decimal Point:** Manual setting to any of 4 positions
**Max. Print Data:** 1999.
**Print Interval:** Continuous, 1, 10, 30 minutes or manual, selectable.
**Paper:** Thermal sensitive, in rolls with data capacity of approx. 2,000 lines/roll (five rolls supplied).
**Power Requirements:** Four 1.5 V batteries, or 100 V AC (using optional adapter).

# POWER MEASURING INSTRUMENTS

## Selection Guide

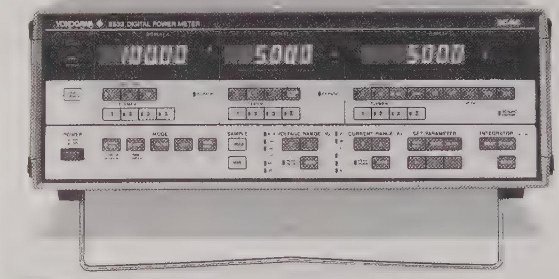
YOKOGAWA offers a full range of high-performance power measuring instruments including standard wattmeter indicators and digital power measuring instruments based on a patented principle of operation. These are ideally suited for measuring the power of distorted waves and their rms value of voltages and currents. YOKOGAWA power measuring instruments are now used as national standards in many countries.

YOKOGAWA's patented method of A-D conversion—using Feedback Pulse Width Modulation Counting Method to convert an analog signal to a pulse-width-modulated signal, and measuring the ratio of pulse widths—provides very high accuracy, and it is easy to provide electrical isolation with a pulse-width-modulated signal.

### ■SELECTION GUIDE

| Function / Model & instrument name | | Power (voltage range × current range) | | | Circuits | Voltage (true rms) | | Current (true rms) | | Type of display (Output) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Voltage range | Current range | Frequency range & accuracy | | Range | Frequency range & accuracy | Range | Frequency range & accuracy | |
| [illegible] Standard Watt Converter | | 75 to 300 V (4 ranges) | 0.5 to 20 A (6 ranges) | 30 Hz to 3 kHz ±0.02 to ±0.07% | Single-phase | — | — | — | — | (Analog) |
| 2533 Digital Power Meter | AC model | 30 to 600 V (6 ranges) | 0.5 to 20 A (6 ranges) | 10 Hz to 20 kHz ±0.1 to ±0.4% | Single-phase<br>3-phase 3-wire | 30 to 600 V (6 ranges) | 10 Hz to 20 kHz ±0.1 to ±0.4% | 0.5 to 20 A (6 ranges) | 10 Hz to 20 kHz ±0.1 to ±0.4% | Digital (Analog, D-A, GPIB, RS-232-C) |
| | DC AC model | | 1 to 20 A (5 ranges) | DC, 10 Hz to 20 kHz ±0.2 to ±0.6% | 3-phase 4-wire | | DC, 10 Hz to 20 kHz ±0.1 to ±2% | 1 to 20 A (5 ranges) | DC, 10 Hz to 20 kHz ±0.1 to ±2% | |
| 250321 & 250323 Digital AC Power Meters | | 3 to 600 V (6 ranges) | 100 mA to 30 A (7 ranges) | 40 Hz to 1.2 kHz ±0.1 to ±0.2% | Single-phase **(250321)**<br>3-phase 3-wire **(250323)** | 3 to 600 V (6 ranges) | DC, 25 Hz to 2 kHz ±0.1 to ±0.2% | 100 mA to 30 A (7 ranges) | 25 Hz to 2 kHz ±0.1 to ±0.2% | Digital (BCD, Analog) |
| 2504 Digital AC Meter | | 30 to 600 V (4 or 5 ranges) | 0.5 to 20 A (4 or 5 ranges) | DC, 40 Hz to 1.2 kHz ±0.25 to ±0.5% | Single-phase | 30 to 600 V (4 or 5 ranges) | DC, 25 Hz to 2 kHz ±0.25 to ±0.5% | 0.5 to 20 A (4 or 5 ranges) | DC, 25 Hz to 2 kHz ±0.25 to ±0.5% | Digital (BCD, analog) |
| 2513 Integrator Module | | Usable as digital AC/DC watthour and ampere-hour meters by combining with the **2504**.<br>Integration Period: 100 to 833 hours at rated input (depending on the ranges selected on the **2504**).<br>Accuracy: ±(0.32% + 1 digit)... overall accuracy in combination with the **2504**. | | | | | | | | Digital |
| 2509 Digital Wattmeter | | 250 V | 1 to 10 A (4 ranges) | 40 to 400 Hz ±0.5 to ±1% | Single-phase | 250 V | 40 to 400 Hz ±0.5 to ±1% | 1 to 10 A (4 ranges) | 40 to 400 Hz | Digital |
| 2524 Digital Power Factor Meter | | 120 to 480 V (3 ranges) | 1 to 10 A (4 ranges) | 40 to 400 Hz ±1 to ±3% (VA value) | Single-phase | 120 to 480 V | 40 to 400 Hz ±0.5 to ±1.5% | 1 to 10 A | 40 to 400 Hz ±0.5 to ±1.5% | Digital (Analog) |

# Digital Power Meter 2533



253323 149×444×364 mm 16 kg (3 phase model)

The 2533 Digital Power Meter can measure effective values of AC voltage from 30 to 600 V (DC voltage can be superimposed), AC current from 500 mA to 20 A , and single-phase power from 15 W to 12 kW. Voltage, current and power measurements can be conducted by simply making a key selection.

The 2533 is an outstanding solution to accurate, effective power measurement of distorted waveforms.

**Simultaneous display of three measured values**

Three values among measured or computed values are simultaneously displayed: V, A, W in each phase or total power„ VA, var. PF and more.

**True rms measurement**

The 2533 can measure triangular and square as well as distorted waveforms based on YOKOGAWA-original "log rms-to-DC conversion system".

**High precision:** Accuracy:±(0.1% of rdg+0.1% of range)(253311).

**Wide band of DC, 10 Hz to 20 kHz**

**Versatile computing functions**

Powerful computing functions include $\overline{V}$, $\overline{A}$, VA, var, and PF.

**External PT and CT scaling**

**Analog output of up to 12 signals**

**GPIB and RS-232-C interfaces (optional)**

**Integration and frequency measuring function (optional)**

**High noise immunity and excellent stability**

**High input impedance**

Approx. 1 MΩ on all ranges. The 2533 can accurately measure even very low power levels that conventional analog instruments have not been able to measure until now.

**Computation:** Apparent power, reactive power & power factor

| Function | | Apparent Power (VA) | Reactive Power (var) | Power Factor (PF) |
|---|---|---|---|---|
| Computing Formula | **1 to 3**<br>(each phase) | $Vi \times Ai$ | $\sqrt{(Vi \times Ai)^2 - Wi^2}$ | $\frac{W_1}{V_1 \times A_1}$ |
| | Σ<br>3-phase<br>3-wire<br>(balanced circuit) | $\frac{V_1+V_3}{2} \times \frac{A_1+A_3}{2} \times \sqrt{3}$ | $\sqrt{\left(\frac{V_1+V_3}{2} \times \frac{A_1+A_3}{2} \times \sqrt{3}\right)^2 - (W_1+W_3)^2}$ | $\frac{W_1+W_3}{\frac{V_1+V_3}{2} \times \frac{A_1+A_3}{2} \times \sqrt{3}}$ |
| | Σ<br>3-phase<br>4-wire<br>(balanced circuit) | $\frac{V_1+V_2+V_3}{3} \times \frac{A_1+A_2+A_3}{3} \times 3$ | $\sqrt{\left(\frac{V_1+V_2+V_3}{3} \times \frac{A_1+A_2+A_3}{3} \times 3\right)^2 - (W_1+W_2+W_3)^2}$ | $\frac{W_1+W_2+W_3}{\frac{V_1+V_2+V_3}{3} \times \frac{A_1+A_2+A_3}{3} \times 3}$ |

Note: Exponential averaging and scaling are also available as standard.

**Input:**

| Input | Model | Voltage | Current |
|---|---|---|---|
| Type of Input | AC | Direct<br>(CT isolation after ranging) | CT isolation<br>(secondary ranging) |
| | AC/DC | Direct<br>(DC CT isolation after ranging) | DC CT isolation<br>(secondary ranging) |
| Rated Input (Range) | AC | 30/60/100/150 | 0.5/1/2/5/10/20 A |
| | AC/DC | 300/600 V | 1/2/5/10/20 A |
| Frequency Range | AC | 10 Hz to 20 kHz | 10 Hz to 20 kHz |
| | AC DC | DC, 10 Hz to 20 kHz | DC, 10 Hz to 20 kHz |
| Max. Allowable Input (for 1 s) | | 3.5×range (peak)<br>or 1,400 Vpk<br>(whichever is less) | 10×range (peak)<br>or 70 Apk<br>(whichever is less) |

**Engineering Units:** m, k, M, V, A, W, VA, Var, Hz, h (hour).

**Sample Rate:** Approx. 2.5 times/s.

**Dielectric Strength:** 3,000 V AC for one minute between the input terminals and case, and between the input and output terminals. 1,500 V AC for one minute between the case and power line, and between the output terminals and power line.

**Power Consumption:** Approx. 40 to 50 VA.

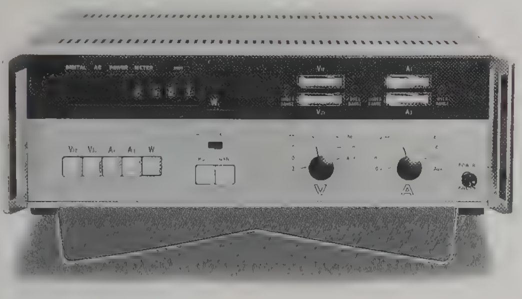
## AVAILABLE MODELS

| Model | Suffix Codes | | | | Description |
|---|---|---|---|---|---|
| **2533** | ······ | ······ | ······ | | Digital power meter |
| | **11** | ······ | ······ | | Single-phase (AC) |
| | **12** | ······ | ······ | | 3-phase 3-wire (AC) |
| | **13** | ······ | ······ | | 3-phase 4-wire (AC) |
| | **21** | ······ | ······ | | Single phase (DC/AC) |
| | **22** | ······ | ······ | | 3-phase 3-wire (DC/AC) |
| | **23** | ······ | ······ | | 3-phase 4-wire (DC/AC) |
| Power Requirement | | **-1** | ······ | | 100 V AC (50 & 60 Hz) |
| | | **-3** | ······ | | 115 V AC (50 & 60 Hz) |
| | | **5** | ······ | | 200 V AC (50 & 60 Hz) |
| | | **7** | ······ | | 230 V AC (50 & 60 Hz) |
| Power Cord | | | **/B** | | JIS standard |
| | | | **/D** | | UL standard |
| | | | **/F** | | VDE standard |
| | | | **/G** | | SAA standard |
| Optional Features | | | | **/GP-IB** | GPIB interface |
| | | | | **RS232C** | RS-232-C interface |
| | | | | **/FRQ** | Frequency measurement |
| | | | | **/INTEG** | Integrator |

## MEASUREMENTS

| Function | | Voltage | Current | Power |
|---|---|---|---|---|
| **Operating Principle** | | True rms (log-antilog)/mean value rectification | True rms (log-antilog) | Feedback time division multiplier |
| **Measurement** | **Single-phase** | $V_1$ | $A_1$ | $W_1$ |
| | **3-phase 3-wire (balanced circuit)** | $V_1,\ V_3,\ \frac{V_1+V_3}{2}(\Sigma)$ | $A_1,\ A_3 \frac{A_1+A_3}{2}(\Sigma)$ | $W_1,\ W_3,\ W_1+W_3(\Sigma)$ |
| | **3-phase 4-wire (balanced circuit)** | $V_1, V_2, V_3, \frac{V_1+V_2+V_3}{3}(\Sigma)$ | $A_1,\ A_2,\ A_3,\ \frac{A_1+A_2+A_3}{3}(\Sigma)$ | $W_1,\ W_2,\ W_3,\ W_1+W_2+W_3(\Sigma)$ |
| **Frequency Range** | **AC Model** | 10 Hz to 20 kHz | 10 Hz to 20 kHz | 10 Hz to 20 kHz |
| | **DC/AC Model** | DC, 10 Hz to 20 kHz | DC, 10 Hz to 20 kHz | DC, 10 Hz to 20 kHz |
| **Crest Factor** | | Up to 2 | Up to 3 (or 50 Apk; DC/AC model) | Corresponds to voltage and current |
| **Display Accuracy**<br>At 23±3°C (73±5°F), 45 to 75 relative humidity, 100 V ±1% sine wave input, 3-month calibration cycle (common mode voltage 0 V, demagnetization...DC/AC model). | | DC: ±(0.1% of rdg+ 0.2% of range)<br>(DC/AC model) | DC: ±(0.1% of rdg+ 0.2% of range+3 mA)<br>(DC/AC model) | At cos$\phi$=1<br>DC: ±(0.1% of rdg+ 0.3% of range<br>(DC/AC model) |
| | | 45 to 60 Hz: ±(0.1% of rdg+ 0.1% of range)...AC model<br>±(0.1% of rdg+ 0.2% of range)...DC/AC model<br>20 to 45 Hz: 66 Hz to 2 kHz<br>±(0.2% of rdg+ 0.2% of range)...AC model<br>±(0.2% of rdg+ 0.4% of range)...DC/AC model<br>10 to 20 Hz: 2 to 10 kHz: ±1% of range<br>10 to 20 kHz: ±2% of range<br>(at 10 to 110% input) | | Corresponds to voltage and current |
| **Power Factor Effect** | | — | — | Less than ±0.5% of rdg<br>(at cos$\phi$=0.5, 50 or 60 Hz) |

## 2503 Digital AC Power Meter



**250323** 149×439×365 mm 16 kg

The 2503 is a 0.1% digital V-A-W meter for single-phase or 3-phase 3-wire circuits. Provides digital readout of true rms voltage, current and power over a wide frequency range.

**Available Models: 250321** (for single phase), **250323** (for 3 phase, 3 wire).
**Max. Reading:** 11900.
**Resolution:** 1 mV, 10 μA, 0.1 mW.
**Unit Marks:** V, mA, A, mW, W and kW.
**Crest Factor:** Up to 3 (V & A).
**Measuring Ranges:** 3 to 600 V, 0.1 to 30 A, 300 mW to 18 kW (250321), 600 mW to 36 kW (250323).
**Frequency Ranges:** V... DC, 25 Hz to 2 kHz, A... 25 Hz to 2 kHz, W... 40 Hz to 1.2 kHz.
**Accuracy:** V and A...±(0.1% of rdg+0.02% of range+1 digit) for 50 to 400 Hz, W...±(0.1% of rdg+0.02% of range+1 digit) for 50 to 400 Hz, ±(0.2% of rdg+0.03% of range+1 digit) for 40 to 50 Hz and 400 Hz to 1.2 kHz.
**Standard Features:** BCD output, remote control and analog output.

## 2504 Digital AC Meter

**250432** with **251416**
149×233×364 mm 9.1 kg

The 2504 is a 0.25% digital V-A-W meter used to measure true rms voltage, current and/or power. The 2504 consists of a mainframe and a plug-in input module. Measurement functions (W or V-A-W) and input ranges are selectable from two different mainframes and three plug-in input modules. Incorporates a "feedback time division multiplier", suitable for accurate power measurements of distorted signals and low power factors.

**Sample Rate:** Approx. 1.5 times/s.
**Max. Reading:** 11900.
**Unit Marks:** mA, A, W and kW.
**Resolution:** 10 mV/digit, 0.1 or 1 mA/ digit, 10 or 100 mW/digit.
**Frequency Range:** 25 Hz to 2 kHz (V and A), 40 Hz to 1.2 kHz (W) , DC for 251416.
**Crest Factor:** Up to 2 (V), 3 (A).
**Accuracy:** V and A...±(0.25% of rdg+0.05% of range) for DC, 47 to 63 Hz, ±(0.5% of rdg+0.1% of range) for 25 to 47 Hz and 63 Hz to 2 kHz, W...±(0.25% of rdg+0.05% of range) for DC, 47 to 63 Hz, ±(0.5% of rdg+0.1% of range) for 40 to 47 Hz and 63 Hz to 1.2 kHz.
**Standard Features:** Analog output, BCD output and remote control.

### AVAILABLE MODELS

| Model | Function |
|---|---|
| 250431 | W direct reading |
| 250432 | V-A-W direct reading |

### PLUG-IN INPUT MODULES

| Model | Input ranges |
|---|---|
| 251406 | 30, 60, 100, 150, 300 V AC<br>0.5, 1, 2, 5, 10 A AC |
| 251407 | 100, 150, 300, 600 V AC<br>2, 5, 10, 20 A AC |
| 251416 | 30, 60, 100, 150, 300 V AC/DC<br>0.5, 1, 2, 5, 10 A AC/DC |

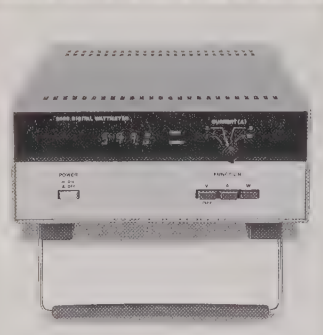
## 2513 Integrator Module

**2513** mated with **2504**
149×444×364 mm 6.0 kg

The 2513 is a combination unit with 2504. The combination instrument composes an integrating meter which is conveniently used as a digital AC and/or DC watthour and amperehour meter (also usable for distorted signals).

**Measuring Ranges:** Depending on the ranges selected on 2504.
**Sample Rate:** Approx. 10 times/s.
**Max. Reading:** ±999999.
**Integrating Period:** 100 to 833 hours at rated input of 2504
**Unit Marks:** mWh, Wh, kWh, mAh, Ah
**BCD Output and Remote Control:** Standard
**Overall Accuracy (in Combination with 2504):** ±(2504 accuracy+0.02% of rdg+1 digit) at 23±3°C, 100 V AC±1%.

## 2509 Digital Wattmeter



**2509** 90×210×330 mm 3.1 kg

Portable digital true rms voltmeter, ammeter and wattmeter in one compact case. Weight has been kept to that of a single-function analog measuring instrument. Prevents erroneous reading, completely eliminates the needs for cumbersome, time-consuming external wiring.

**Digital reading of true rms V, A or W**
**Wide-ranging measurement–75 to 275 V rms, 0.3 to 11 A rms, 250 to 2,500 W**
**Precision power measurement by patented feedback time division multiplier**

**Input Ranges:** 250 V, 1, 2, 5, 10 A, 250, 500, 1,250, 2,500 W.
**Resolution:** 100 mV/digit, 1 mA/digit, 100 mW/digit.
**Frequency Range:** 40 to 400 Hz.
**Crest Factor:** Up to 2 (voltage), up to 3 (current).
**Accuracy:** ±(0.5% of rdg +0.1% of range) from 47 to 63 Hz.
**Sample Rate:** Approx. 2 times/s.
**Max. Reading:** 5990.
**Effective Measuring Range:** 30 to 110% of input range (voltage and current).
**Response Time:** Approx. 3 s.
**Out of Range Indication:** OVER and UNDER indicators.

## 2885 Standard Watt Converter

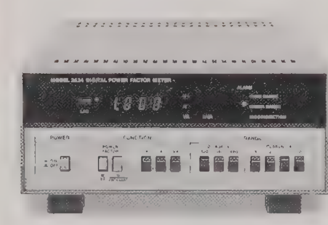
**2885** 149×233×364 mm 8.5 kg

The 2885 converts AC power to DC voltage on the basis of a precision analog multiplier using the "feedback time division method". The 2885 makes analog calculations with an accuracy of 0.02% of rated power—the highest accuracy among existing wattmeters for commercial frequencies.

**0.02% accuracy**
**Wide measuring range**
75 to 300 V in 4 ranges, 0.5 to 20 A in 6 ranges.
**Frequency range from 30 Hz to 3 kHz**
**Auxiliary multiplier input**

**Rated Input:** 75, 100, 150, 300 V AC, 0.5, 1, 2, 5, 10, 20 A AC.
**Maximum Allowable Input (for less than 1s) :** Voltage···2 times rated voltage (peak value), current···5 times rated current (peak value).
**Output:** 1 or 5 V DC, at rated power=(rated voltage)×(rated current)×(unity power factor).
**Frequency Range:** 30 Hz to 3 kHz.
**Accuracy:** ±0.02% of rated power, at (100 V range)×(5 A range), 47 to 63 Hz, unity and/or zero power factor, ±0.05% of rated power, at (100 V range)×(5 A range), 63 to 400 Hz, unity and/or zero power factor. Other input ranges...Add ±0.02% of rated power to the above accuracy.
**Power Requirements:** 100, 120, 200, 220 or 240 V AC (must be specified), 47 to 63 Hz.
**Power Consumption:** Approx. 20 VA.

## 2524 Digital Power Factor Meter



**2524** 90×210×330 mm 3.0 kg

The 2524 measures true power factor, power factor, true rms voltage, true rms current (basic functions), and active, apparent or reactive power (optional). Analog output is available for each measurement.

**Direct digital readout of true power factor**
**Over- and under-range indicators**
**3-phase circuit can be measured using 2 or 3 units**

**Sample Rate:** Approx. 4 times per second.
**Maximum Reading:** 1999, LED display.
**Power Factor Lamp:** LEAD or LAG.
**Unit Marks:** V and A (basic functions), VA, kVA, W, kW or VAR, KVAR (optional function).
**Effective Measuring Range:** 30 to 120% of input range (V and A), 50 to 120% of rated value (VA, W, VAR and power factor)
**Response Time:** Approx. 3 seconds.
**Analog Output:** Power factor ... LEAD (1 mV/digit), LAG (–1 mV/digit), V···1.2 V DC for rated input, A···1.0 V DC for rated input. VA... 1.2 V DC for rated input.
**Power Requirements:** 100, 110, 120, 200, 220, 230 or 240 V AC (must be specified), 50 and 60 Hz.
**Power Consumption:** Approx. 6 VA.

| Fuction | Standard | | | | Power...optional (one must be specified) | | |
|---|---|---|---|---|---|---|---|
| | Power factor | | V | A | **252400** | **252410** | **252420** |
| | $\frac{W}{Vrms\ Arms}$ | $\frac{W}{\sqrt{W^2+VAR^2}}$ | | | Apparent VA | Active W | Reactive VAR |
| Rated value (input ranges) | 0.5 Lag to 1.0 to 0.5 Lead | | 120, 240, 480 V | 1, 2, 5 10 A | 120 VA to 4.8 kVA | 120 W to 4.8 kW | 120 var to 4.8 kvar |
| Resolution | 0.001 | 0.001 | 0.1 V | 1 mA | 0.1 VA | 0.1 W | 0.1 var |
| Frequency range | 40 to 400 Hz | 50, 60 ±0.2 Hz | 40 to 400 Hz | | | | 50, 60 ±0.2 Hz |
| Crest factor | See V, A | 1.4 (sine wave) | Up to 2 (voltage), up to 3 (current) | | | | |
| Accuracy | rdg±0.015, or rdg ±0.03 | rdg ±0.015 | 0.5% or 1.5% of rdg | | 1% or 3% of rdg | | 0.5% of rdg |

# 2222 · 2241 to 2244 · 2261 · 2262

## 2222 External Multipliers

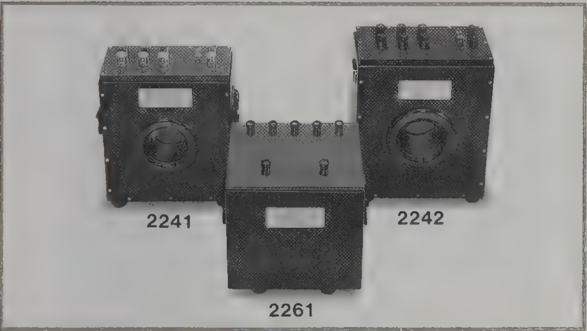
**222203** 190×100×200 1.2 kg

**Accuracy Class:** Class 0.2.
**Current Loss:** 1 mA

### AVAILABLE MODELS

| Model | Rating | Current Loss |
|---|---|---|
| 222201 | 0.75/1.5 kV | 1 mA |
| 222202 | 1/2 kV | |
| 222203 | 1.5/3 kV | |

## 2241 to 2244, 2261 & 2262 Transformers



The main reason to use current and potential transformers is to expand measuring ranges in the high voltage/current circuits and to isolate measuring instruments from the high voltage circuit.

A wide range of transformers are available from YOKOGAWA, including ±0.1% accuracy current transformer 2243 and ±0.2% accuracy potential transformer 2262 for 6,600 V circuit.

### AVAILABLE MODELS

| Model | Current Transformers | | | Potential Transformers | | | |
|---|---|---|---|---|---|---|---|
| | 224100 | 224200 | 224300 | 226101 | 226102 | 226103 | 226200 |
| Primary rating | 10/15/30/50/100/250/300/500/750/1,500 A | 10/15/30/50/100/250/300/500/750/1,500 A | 0.5/0.75/1/1.5/2/3/5/7.5/10/15/20/30/50/75/100 A | 220/440/2,200/3,300 V | 15/30/50/75 V | 100/200/300/500 V | 3,300/6,600 V |
| Secondary rating | 5 A | 5 A | 5 A | 110 V | 150 V | 150 V | 110 V |
| Rated burden | 15 VA | 15 VA | 15 VA | 15 VA | 15 VA | 15 VA | 15 VA |
| Max. ratio error | ±0.2% | ±0.2% | ±0.1% | ±0.2% | ±0.2% | ±0.2% | ±0.2% |
| Max. phase displacement | ±10 minutes | ±10 minutes | ±5 minutes | ±10 minutes | ±10 minutes | ±10 minutes | ±10 minutes |
| Accuracy | ±0.2% | ±0.2% | ±0.1% | ±0.2% | ±0.2% | ±0.2% | ±0.2% |
| Max. line voltage | 3,450 V | 6,900 V | 250 V | – | – | – | – |
| Dielectric test voltage for one minute | 10,000 V | 20,000 V | 2,000 V | 10,000 V | 2,000 V | 4,000 V | 15,000 V |
| Rated frequency | 50 to 60 Hz | | | 50 to 60 Hz | | | |
| Dimensions | 318×246×128 mm | 349×267×152 mm | 343×256×136 mm | 255×240×200 mm | | | 294×251×216 mm |
| Weight | 9 kg | 11 kg | 12.5 kg | 18 kg | | | 18 kg |

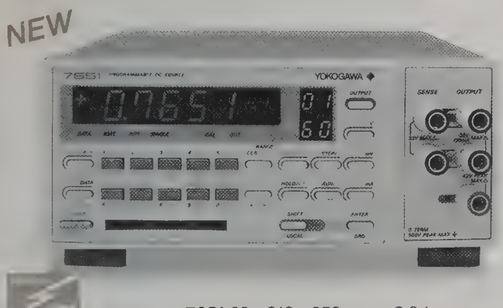
**2244**
**Primary Rating:** 500 A (Single range).
**Secondary Rating:** 5 A.
**Rated Burden:** 1.5 VA.
**Accuracy:** ±0.2%.
**Max. Line Voltage:** 250 V.

YOKOGAWA's Voltage/Current Standards are precision instruments based on recent progress in electronic circuit components and circuit design technology. By just simple operation, these instruments are capable of generating wide-range DC or AC voltages and currents for adjustment and calibration of indicating instruments, recorders and industrial instruments, as well as for experimental research, from the laboratory to the factory. These standards provide highly accurate, labor saving measurements where quality and reliability are essential.

## SELECTION GUIDE

| Model | Function (Supply) | Range | Output | Accuracy of Output | Max. Output (Approx.) | Description |
|---|---|---|---|---|---|---|
| [illegible] | DC Volts | 10 mV<br>100 mV<br>1 V<br>10 V<br>30 V | −12.0000 mV to +12.0000 mV<br>−120 000 mV to +120.000 mV<br>−1.2 V to +1.2 V<br>−12 V to +12 V<br>-32 V to +32 V | ±(0.018% of setting + 4 μV)<br>±(0.018% of setting + 10 μV)<br>±(0.01% of setting + 100 μV)<br>±(0.01% of setting + 200 μV)<br>±(0.01% of setting + 500 μV) | —<br>—<br>±120 mA<br>±120 mA<br>±120 mA | |
| | DC Amps | 1 mA<br>10 mA<br>100 mA | −1.20000 mA to +1.20000 mA<br>−12.0000 mA to +12.0000 mA<br>−120.000 mA to +120 000 mA | ±(0.02% of setting + 0.1 μA)<br>±(0.02% of setting + 0.5 μA<br>±(0.02% of setting + 5 μA) | ±30 V<br>±30 V<br>±30 V | |
| [illegible] | DC Volts | 1,000 mV<br>10 V<br>100 V<br>1,000 V | 0 to 1199.999 mV<br>0 to 11.99999 V<br>0 to 119.9999 V<br>0 to 1199.999 V | ±(0.005% of setting) or ±10 μV<br>±(0.005% of setting) or ±50 μV<br>±(0.005% of setting) or ±500 μV<br>±(0.005% of setting) or ±5 mV | 25 mA<br>25 mA<br>25 mA<br>10 mA | |
| [illegible] | DC Volts | 10 mV<br>100 mV<br>1 V<br>10 V | 0 to 12.000 mV<br>0 to 120.00 mV<br>0 to 1.2000 V<br>0 to 12.000 V | +(0.02% of range +4 μV)<br>±0.02% of range<br>±0.02% of range<br>±0.02% of range | 1 kΩ<br>1 kΩ<br>120 mA<br>120 mA | emf output (5 TC types), output divider, GPIB (optional) |
| | DC Amps | 1 mA<br>10 mA<br>100 mA | 0 to 1.2000 mA<br>0 to 12.000 mA<br>0 to 120.00 mA | ±0.02% of range<br>±0.02% of range<br>±0.02% of range | 15 V<br>15 V<br>9 V | |
| [illegible] | DC Volts | 10 mV<br>100 mV<br>1 V<br>10 V<br>100 V | 0 to 11.999 mV<br>0 to 119.99 mV<br>0 to 1.1999 V<br>0 to 11.999 V<br>0 to 119.99 V | ±(0.05% of setting + 1 μV)<br>±(0.05% of setting + 10 μV)<br>±(0.05% of setting + 100 μV)<br>±(0.05% of setting + 1 mV)<br>±(0.05% of setting + 10 mV) | Internal resistance <2.5 Ω<br>Internal resistance <2.5 Ω<br>10 mA<br>10 mA<br>1 mA | Ni-Cd battery/line operation |
| | DC Amps | 1 mA<br>10 mA<br>100 mA | 0 to 1.1999 mA<br>0 to 11.999 mA<br>0 to 119.99 mA | ±(0.05% of setting + 0.1 μA)<br>±(0.05% of setting + 1 μA)<br>±(0.05% of setting + 1 mA) | 15 V<br>15 V<br>6 V | |
| [illegible] | DC Volts | 10 mV<br>100 mV<br>1 V<br>10 V | 0 to 11 mV<br>0 to 110 mV<br>0 to 1.1 V<br>0 to 11 V | ±(0.1% + 10 μV)<br>±(0.1% + 100 μV)<br>±(0.1% + 1 mV)<br>±(0.1% +10 mV) | —<br>—<br>100 mA<br>100 mA | |
| | DC Amps | 1 mA<br>10 mA<br>100 mA | 0 to 1.1 mA<br>0 to 11 mA<br>0 to 110 mA | ±(0.2% + 1 μA)<br>±(0.2% + 10 μA)<br>±(0.2% + 100 μA) | 10 V<br>10 V<br>10 V | |
| [illegible] | DC Volts | 100 mV<br>1 V<br>10 V<br>30 V | 0 to ±120.00 mV<br>0 to ±1200.0 mV<br>0 to ±12.000 V<br>0 to ±36.00 V | ±(0.1% of rdg + 0.02% of range)<br>±(0.05% of rdg + 0.02% of range)<br>±(0.05% of rdg + 0.02% of range)<br>±(0.05% of rdg + 0.06% of range) | 20 mA<br>20 mA<br>5 mA | Internal resistance (approx): 5 Ω |
| | DC Amps | 20 mA | 0 to ±24.00 mA | ±(0.1% of rdg + 0.1% of range) | 12 V | |
| 2854 | DC Amps | 1st dial<br>2nd dial<br>3rd dial<br>4th dial | 0 to 100 mA<br>1 to 6.75 mA<br>0 to 0.45 mA<br>0 to 40 μA | ±(0.5% of setting) | 10 V | |
| 255001 | DC Volts | Same as **2552** | | | | **2552**, current and deviation units |
| | DC Amps | 100 μA<br>1 mA<br>10 mA<br>100 mA<br>1 A<br>10 A<br>30 A | 0 to 119.9999 μA<br>0 to 1.199999 mA<br>0 to 11.99999 mA<br>0 to 119.9999 mA<br>0 to 1.199999 A<br>0 to 11.99999 A<br>0 to 35.9999 A | ±(0.02% of setting) or ±2 nA<br>±(0.01% of setting) or ±10 nA<br>±(0.01% of setting) or ±100 nA<br>±(0.01% of setting) or ±1 μA<br>±(0.03% of setting) or ±30 μA<br>±(0.1% of setting) or ±1 mA<br>±(0.2% of setting) or ±18 mA | 20 V<br>20 V<br>20 V<br>20 V<br>10 V<br>1.5 V<br>1 V | |
| | % Deviation | ±0.6%, ±3.0% | | | | |
| 255002 | DC Volts | Same as **2552** | | | | **2552** and deviation unit |
| | % Deviation | ±0.6%, ±3.0% | | | | |
| 255003 | DC Volts | Same as **2552** | | | | **2552** and current unit |
| | DC Amps | Same as **255001** DC Amps | | | | |
| [illegible] | DC Volts | 10 V, 1 V, 100 mA, 10 mA | Same as **2553** | | | % deviation, output divider, sweep mode, GPIB (optional) |
| | | 100 V<br>500 V<br>1,000 V | 0 to 120.00 V<br>0 to 600.0 V<br>0 to 1200.0 V | ±(0.15% + 20 mV)<br>±(0.15% + 200 mV)<br>±(0.15% + 200 mV) | 20 mA<br>10 mA<br>5 mA | |
| | | 100 mV | 0 to 120.00 mV | ±(0.2% + 0.02 mV) | Internal resistance 10 mΩ | |
| | DC Amps | 100 mA, 100 mV,10 mV | Same as **2553** | | | emf output (5 TC types) |
| | | 1 A<br>10 A<br>30 A | 0 to 1 2000 A<br>0 to 12 000 A<br>0 to 36 00 A | ±(0 2% + 0.2 mA)<br>±(0 2% + 2 mA)<br>±(0 2% + 20 mA) | 10 V<br>1 V<br>1 V | |
| | | 10 μA<br>50 μA<br>100 μA | 0 to 12 00 μA<br>0 to 60 00 μA<br>0 to 120.0 μA | ±(0 3% + 5 nA<br>±(0 3% + 20 nA)<br>±(0 3% + 20 nA) | 0.25 V<br>1 25 V<br>2.5 V | |
| [illegible] | AC Volts | 100 mV<br>1 V<br>10 V<br>100 V<br>300 V<br>1,000 V | 1.00 to 120.00 mV<br>0.0100 to 1.2000 V<br>0.100 to 12.000 V<br>1.00 to 120.00 V<br>3.00 to 360.0 V<br>10.0 to 1200.0V | 50/60 Hz...±(0.08% of setting +0.015% of range)<br>Less than 20% of range....<br>±0.02% of range | Output resistance 10 Ω<br>0 5 A<br>3 A<br>0 3 A<br>0 1 A<br>6 mA | % deviation, output divider, sweep mode, GPIB (optional) |
| | AC Amps | 100 mA<br>1 A<br>10 A<br>50 A | 1.00 to 120.00 mA<br>0.0100 to 1.2000 A<br>0 100 to 12.000 A<br>0.50 to 60.00 A | (50 A range)<br>50/60 Hz...±(0.15% of setting +0.015% of range)<br>Less than 20% of range....<br>±0.04% of range | 30 V<br>30 V<br>3 V<br>0 6 V | |

## 7651 Programmable DC Source



**7651** 88×213×350 mm 3.6 kg

The 7651 is a general-purpose DC source that enables the compatibility of high-speed response and high resolution. The 7651 also provides high accuracy and stability. In addition to the source function, the sink function is also available, so the 7651 can be used as not only DC voltage/current source but also high-precision electronic load. Further, a series of powerful functions to meet the system use such as the programming function up to 50 steps, the IC memory card capable of storing 7 patterns of programs, and GPIB or RS-232-C interface are provided as standard.

**High precision output**

**High accuracy:** ±0.01% of setting ±200 µV (10 V range, 90 days, 23±5°C), ±0.02% of setting ±100 nA (1 mA range, 90 days, 23±5°C)

**High resolution:** 100 nV (DC V, 10 mV range)

**High-speed response:** 10 ms/±0.1%

**Low noise:** 15 µVp-p (1 V range, DC to 10 Hz)

**Sink and source capability**

In addition to the source function, the sink is available, so the 7651 can be used as a constant current electronic load.

**Bipolar output, glitchless**

The bipolar output of the 7651 executes polarity switching without using mechanical contact, so any abnormal voltage or current is not generated at the polarity switching. Because of this feature, true continuous output change from the negative maximum output to the positive maximum output becomes possible.

**Programmable voltage/current limiter**

Limiting point is programmable within the range of 1 to 30 V as the voltage limiter, and within the range of 5 to 120 mA as the current limiter.

**Programming function**

50-step output data can be stored.

**Operating Principle:** Multiplication type dual D-A conversion.

**Output Setting:** +120,000 (setting range), continuous variable mode, data mode.

**Display:** 7-segment LED.

**Unit Indication:** 5×7 dot-matrix LED, mV/V/mA.

**Overload Indication:** "-oL-" sign display.

**Allowable Input Voltage:** 32 V/120 mA between Hi-Lo, 42 V peak between Lo-G, 500 V peak between G-Case.

**Power Supply:** 100/115 V AC ±10% or 200/230 V AC ±10%, 50/60Hz, selectable by switch.

**Power Consumption (approx.):** 30 VA.

### DC VOLTAGE (DC V)

| Range | Maximum Output | Resolution | Stability (90 days) ±(% of setting+µV) | Accuracy (90 days) ±(% of setting+µV) | Maximum Output Current |
|---|---|---|---|---|---|
| 10 mV | ±12.0000 mV | 100 nV | 0.014+4 | 0.018+4 | – |
| 100 mV | ±120.000 mV | 1 µV | 0.014+5 | 0.018+10 | – |
| 1 V | ±1.20000 V | 10 µV | 0.008+50 | 0.01 +100 | ±120 mA |
| 10 V | ±12.0000 V | 100 µV | 0.008+100 | 0.01 +200 | ±120 mA |
| 30 V | ±32.000 V | 1 mV | 0.008+200 | 0.01 +500 | ±120 mA |

### DC CURRENT (DC A)

| Range | Maximum Output | Resolution | Stability (90 days) ±(% of setting+µA) | Accuracy (90 days) ±(% of setting+µA) | Maximum Output Voltage |
|---|---|---|---|---|---|
| 1 mA | ±1.20000 mA | 10 nA | 0.016+0.1 | 0.02+0.1 | ±30 V |
| 10 mA | ±12.0000 mA | 100 nA | 0.016+0.5 | 0.02+0.5 | ±30 V |
| 100 mA | ±120.000 mA | 1 µA | 0.016+5 | 0.02+5 | ±30 V |

### AVAILABLE MODELS

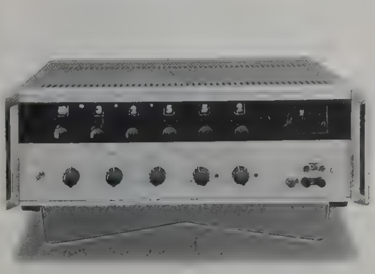
| Model | Suffix Codes | Option Codes | Description |
|---|---|---|---|
| 765101 | ········ | ········ | With front output terminal, GPIB |
| 765102 | ········ | ········ | With front output terminal, RS-232 C |
| 765111 | ········ | ········ | With rear output terminal, GPIB |
| 765112 | ········ | ········ | With rear output terminal, RS 232-C |
|  | -A ··· | ········ | Always **A** (version code) |
| Power Requirements | -1 | ········ | 100 V AC (50 & 60 Hz) 115 V AC changeable |
|  | -3 | ········ | 115 V AC (50 & 60 Hz) 100 V AC changeable |
|  | -5 | ········ | 200 V AC (50 & 60 Hz) 230 V AC changeable |
|  | -7 | ········ | 230 V AC (50 & 60 Hz), 200 V AC changeable |
| Power Cord |  | /B ······ | JIS standard |
|  |  | /D ······ | UL standard |
|  |  | /F ······ | VDE standard |
|  |  | /G ······ | SAA standard |

**Standard Accessories:** Fuse (2 pcs.), remote connector, instruction manual and power supply cord

### OPTIONAL ACCESSORY

| Code | Name |
|---|---|
| 378901 | IC memory card (setting data), 8k bytes |

## 2552 DC Voltage Standard



**2552** 146×439×415 mm 19 kg

The 2522 is a programmable DC voltage standard which delivers an output of 0 to ±1,200 V all with ±0.005% accuracy. Output can be set by six decade dials.

**±0.005% accuracy**

**0 to ±1,200 V DC in 4 ranges**

1,000 mV, 10 V, 100 V, 1,000 V

**PWM DC potentiometer**

**Voltage trip and current limiter**

**Remote programming or BCD output option**

**Output polarity switch-selectable**

**Voltage Ranges:**

| Range | Output Voltage | Steps |
|---|---|---|
| 1,000 mV | 0 to ±1,199.999 mV | 1 µV |
| 10 V | 0 to ±11.99999 V | 10 µV |
| 100 V | 0 to ±119.9999 V | 100 µV |
| 1,000 V | 0 to ±1,199.999 V | 1 mV |

**Accuracy of Output:** ±0.005% of setting

**Stability of Output:** (±0.0005% of setting or ±2 µV)/hour

**Settling Time:** (time required to attain a value within ±0.005% of final output after change of range or set value, not including polarity change), 500 ms on 1,000 mV, 10 and 100 V ranges, 3 s on 1,000 V range

**Available Models:** **255201** standard.
**255202** with remote control.
**255203** with BCD output

## 2553 DC Voltage/Current Standard

**2553** 149×233×364 mm 8 kg

Ultra-stable, high-resolution DC source which delivers voltage and current output using three dials. Features five TC ranges conforming to ANSI, DIN or JIS. It can be remotely programmed and controlled using an optional GPIB.

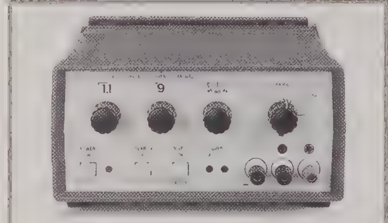
**±0.02% accuracy on all ranges**
**emf output for 5 TC types conforming to ANSI, DIN or JIS**
**Output divider from 1 to 15 divisions**
**Non-contact output setting**
**Fully protected against overload and short circuits**
**Optional semiconductor probe with built-in reference junction compensator**

**Output Ranges:** Voltage .. 10, 1 V, 100, 10 mV, current . 100, 10, 1 mA.
**Output Setting:** 3 dials on the front panel.
**Output Unit Marks:** mV, V, mA or ℃.
**Temperature Coefficient:** 50 ppm/℃.
**Semiconductor Probe (Optional) :** −20 to 60℃ (±0.3℃ accuracy).
**Temperature Setting Ranges:** Type R, K, E, J, T (0.1℃ or 1℃ resolution).
**Power Requirements:** 100, 120, 200, 220, or 240 V AC (must be specified), 50 and 60 Hz.
**Power Consumption:** 50 VA max.

### AVAILABLE MODELS

| Model | Temperature Setting Range | Description |
|---|---|---|
| 255341 | JIS or ANSI (℃) | Standard |
| 255342 | | Standard with GPIB |
| 255320 | DIN (℃) | Standard |
| 255321 | | Standard with GPIB |

## 2554 Portable DC Voltage/Current Standard



**2554** 100×210×230 mm 4 kg

The 2554 is a ±0.05% V/A standard packed into a compact case. Operates on rechargeable Ni-Cd battery or line power. Provides 100 V range and maximum output of 15 V on 100 mA range.

**0 to 120 V, 0 to 120 mA all with ±0.05% accuracy**
**Ni-Cd battery or line power operation**
**Compact, easily portable**
**Over-voltage and -current protection**
**Polarity selection**
**Optional reference junction compensator**

**Power Requirements:** 100, 115, 120, 200, 215, 220, 230 or 240 V AC (must be specified), 50 and 60 Hz or 8 V DC (Ni-Cd battery).
**DC Power Source:** 8 V DC rechargeable Ni-Cd battery (built in), recharging time; approx. 15 hours, continuous operating time; approx 3 hours at full load
**Power Consumption:** Approx. 8 VA at maximum load, approx. 15 VA under battery recharging.

## 2555 DC Voltage/Current Standard

**2555** 138×42×374 mm 2.2 kg

Compact, stable DC source which delivers output voltage from 0 to 11 V, and output current from 0 to 110 mA with a setting accuracy of ±0.1% or ±0.2%. When combined with a high-sensitivity recorder or DC amplifier, 2555 allows cancellation of DC levels superimposed on input signal. This function is convenient for expanded-scale recording of DC-superimposed, small-amplitude signals.

**Excellent stability and high resolution: 2 μV/div., 200 nA/div.**
**0 to 11 V in 4 ranges, 0 to 110 mA in 3 ranges**
**Setting accuracy: ±(0.1%+10 μV) on 10 mV range**
**Easy-to-use pushbutton and dial operation**
**Compact, lightweight**
**Rack mounting or portable**

**Power Requirements:** 100, 120, 200, 220, or 240 V AC (must be specified), 50 and 60 Hz.
**Power Consumption:** 8 VA max. at no load, 10 VA max. at full load.

## 2854 DC Precision Current Supply

**2854** 149×233×364 mm 6 kg

The 2854 is capable of furnishing stable DC current from ±1 to ±105 mA in 7 or more digits with simple dial setting. Eliminates troublesome battery charging, time required to stabilize emf, and emf variations resulting from intermittent discharging.

**Output Current:** ±1 mA to 107.25 mA DC.
**Max. Output:** 10 V DC.
**Stability:** ±5 ppm/10min, ±20 ppm/h, ±20 ppm/℃.
**Output Setting:** No. 1 dial ...5 mA×20 steps, No. 2 dial ...0.25 mA×23 steps, No. 3 dial ...20 μA × 23 steps, No. 4 dial ... 0 to 40 μA (0.08 μA/div. continuously variable)
**Accuracy:** ±0.5% of setting.
**Power Requirements:** 100, 115, 200, 215, or 230 V AC, 50 or 60 Hz (must be specified).
**Power Consumption:** Approx. 11 VA.

# VOLTAGE/CURRENT STANDARDS

## 2422 Portable Calibrator

**2422** 257×182×40 mm 1.2 kg

The 2422 is equipped with a measuring function in addition to the DC standard generator function which is capable of generating DC V, DC mA, and thermo-emf (Types K, E, J, T and R). This combination produces simultaneous displaying of both generation and measurement values on its LCD. The 2422 weighs only 1.2 kg and its built-in Ni-Cd battery provides superior portability which makes it ideal for field use.

**Simultaneous display of output supply and input measurement**
**Compact and lightweight (B5 Magazine size, 1.2 kg)**
**Auto-stepping output & output dividing functions**
**Direct thermometer calibration**
**Built-in Ni-Cd battery/AC power operation**

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**Setting Time:** Approx. 1 s.
**Divided Output:** Output = set value × n/m, m (no. of divisions) ≦15, n = 0, 1, 2...m.
**Set-Value Memory:** 20 steps (10 steps × 2, excluding polarity signal).
**Auto Step:** n/m and memory channel automatic feed, step time...2, 5, 10, 20 s.
**Output Monitor:** Load current monitor at 1, 10 and 30 V ranges (accuracy ±0.2 mA), load voltage monitor in 20 mA range (accuracy ±0.2 V).
**Output Limiter:** Activated under load of more than maximum output (manual return).
**Output Setting:** 4-digit UP/DOWN.
**Display:** 4-1/2 digit LCD.
**RJC Sensor Measuring Range:** −10 to 50°C, 14 to 122°F (accuracy in combination with 2422...±0.5°C at 23±5°C, ±1°C at −10 to 50 °C).
**Power Source:** AC adapter/internal Ni-Cd batteries.
**Optional Accessories:** RJC sensor (**B9638CR**), terminal block (**B9638BM**).

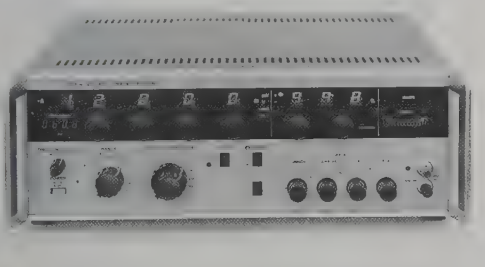
### AVAILABLE MODELS

| Model | Description | |
|---|---|---|
| | AC Adapter | Corresponding TC emf |
| **242211** | 120 V | ANSI |
| **242212** | 220 to 240 V | ANSI |
| **242221** | 220 to 240 V | DIN |

| Range | | | Generating and Measuring Ranges | Accuracy (23±5°C)*1 |
|---|---|---|---|---|
| Generation Ranges | 30 V | | 0 to ±36.00 V | ±(0.05% of rdg +0.06% of range) |
| | 10 V | | 0 to ±12.000 V | ±(0.05% of rdg +0.02% of range) |
| | 1 V | | 0 to ±1200.0 mV | ±(0.05% of rdg +0.02% of range) |
| | 100 mV | | 0 to ±120.00 mV | ±(0.1% of rdg +0.02% of range) |
| | TC | K | −200.0 to +1370.0°C,<br>−328.0 to +2502°F | ±(0.1% of rdg + 0.5°C), (0.1% of rdg +2°F) |
| | | E | −200.0 to +700.0°C,<br>−328.0 to +1292°F | ±(0.1% of rdg +0.5°C), ±(0.1% of rdg + 1.0°F) *2 |
| | | J | −200.0 to +1000.0°C,<br>−328 to +1832°F | |
| | | T | −200.0 to +400.0°C,<br>−328 to +752°F | |
| | | R | −40 to +1600°C,<br>−40 to +3216°F | ±(0.1% of rdg +1.5°C), ±(0.1% of rdg + 2.7°F) |
| | 20 mA | | 0 to ± 24.00 mA | ±(0.05% of rdg +0.06% of range) |
| | Reference resistance | | 100 Ω | ±0.2% |
| Measuring Ranges | 30 V | | ±36.000 V | ±(0.1% of rdg +2 digits) |
| | 10 V | | ±11.999 V | |
| | 1 V | | ±1199.9 mV | |

*1) Voltage drop due to the load current through the attached lead is not included (lead resistance is about 0.08 Ω)
*2) Accuracy of TC range does not include the error of RJC

## 2558 AC Voltage/Current Standard



**2558** 149×438×415 mm 23 kg

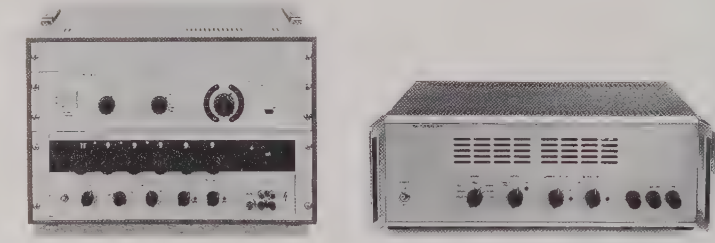
Precision, stable AC voltage and current source. Output voltage or current set using front-panel four dials, is controlled by digital signals through photocouplers and microprocessors, and displayed on a red 5-digit LED.

**±0.08% accuracy**
**1 mV to 1200 V in 6 ranges, 1 mA to 60 A in 4 ranges**
**Frequency ranges—50, 60, 400 Hz or 40 to 500 Hz continuously variable**
**Sweep mode**
**Large output capacity—30 V max. on 100 mA range, 0.5 A max. on 1 V range**
**% deviation readout**
**Output divider**
**Remote control and programming using optional GPIB**

**Output Ranges:** 100 mV, 1, 10, 100, 300, 1000 V, 100 mA, 1, 10, 50 A.
**Accuracy:** 50 or 60 Hz...±0.08% of setting on all except 50 A range, ±0.15% of setting on 50 A range, 400 Hz...0.1% of setting on all except 50 A range, ±0.2% of setting on 50 A range.
**Resolution:** 10 μV on 100 mV range, 10 μA on 100 mA range.
**Distortion:** Voltage output ... 0.07% of range, current output ...0.18% of range.
**Output setting:** 4 dials.
**Setting Value Indication:** 5-digit red LED.
**Output Unit Marks:** mV, V, mA or A.
**Stability:** ±0.03% of range/h.
**Calibration Cycle:** 3 months.
**Sweep Speed:** 16 s for sweep from 0 to 100% of setting of 100% to 0
**Frequency Range (Sine Wave):** 50, 60 or 400 Hz ±1% (40 to 500 Hz continuously variable)
**Power Consumption:** Approx. 200 VA
**GPIB:** Optional

## DC Calibration Sets 2550 · 2560

### 2550 DC Calibration Sets



**255001** DC voltage/current calibration set

Offer quick, simple testing and calibration of DC instruments. Selectable from the following three different models. Using Deviation Unit, the testing or calibration deviation can be read directly in percent of rated value without the need for cumbersome, time-consuming calculation.

#### AVAILABLE MODELS

| Model | Name | Composition | Function |
|---|---|---|---|
| **255001** | DC voltage/current calibration set | **2552, CU** and **DU** | **See 2552** |
| **255002** | DC voltage calibration set | **2552** and **DU** | |
| **255003** | DC voltage/current standard | **2552** and **CU** | |

**DU** Deviation Unit, **CU** Current Unit

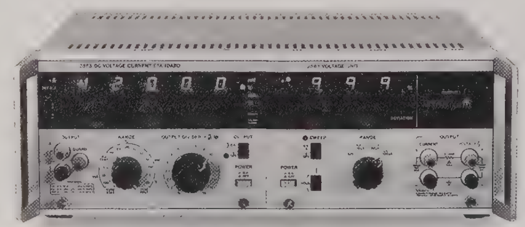
**Deviation Unit (DU)**
**Function Dial:** TH, FS, 100, 120 or 150 (division scale)
**Division Dial:** 0 to 150 (15 divisions, 10 steps).
**Deviation Dial:** −0.6 to +0.6%, or −3.0 to +3.0% of **2552** or Current Unit setting.

**Current Unit (CU)**
**Current Ranges, Accuracy of Output:** See **2552.**
**Current Trip:** Automatically sets output to zero at approx. 1.2, 12, 20 or 36 A on all ranges.
**Voltage Limit:** Automatically limits output voltage at approx. 5, 10, 15 or 20 V on all ranges.

**Temperature Coefficient of Output:**

| Range | Temperature Coefficient (% of setting) |
|---|---|
| 100 μA | ±(0.002% + 0.3 nA)/ C |
| 1,000 μA | ±(0.001% + 2 nA)/°C |
| 10 mA | ±(0.001% + 20 nA)/°C |
| 100 mA | ±(0.001% + 200 nA)/°C |
| 1,000 mA | ±(0.03% + 4 μA)/°C |
| 10 A | ±(0.01% + 200 μA)/°C |
| 30 A | ±(0.02% + 3 mA)/°C |

### 2560 DC Calibration Sets



**256041 or 256043** 149×439×415 mm 13.5 kg

Stable, precision DC sources which assure simple, fast testing and calibration of DC instruments. Feature many versatile functions including a fractional output divider, %-error measurement, and sweep mode.

**High accuracy—±0.02% to ±0.3%**
**Wide output ranges**
**Non-contact output setting for long-term reliable operation**
**Output divider from 1 to 15 divisions**
**% deviation readout**
**Sweep mode**
**Fully programmable using optional GPIB**

#### AVAILABLE MODELS

| Model* | Composition |
|---|---|
| 2560□1 | **2553** DC voltage/current standard and voltage unit |
| 2560□2 | **2553**, voltage unit and current unit |
| 2560□3 | **2553** and voltage unit with GPIB |
| 2560□4 | **2553**, voltage unit and current unit with GPIB |

* Specify temperature setting range in □ by one of the follwing codes 4 for JIS or ANSI (°C), or 2 for DIN (°C)

**Voltage Unit:** 200, 500, 1000 V, 10, 50, 100 μA ranges, ±0.15% to ±0.3% setting accuracy.
**Current Unit:** 1, 10, 30 A, 100 mV ranges, ±0.2% setting accuracy.
**Output Setting:** 3 dials.
**Output Unit Marks:** mV, V, mA or °C.
**% Deviation Setting:** 2 dials.
**Sweep Speed:** 16 s for sweep from 0 to 100% of setting or 100% to 0.

# Selection Guide

The thermometer is available in many types using different principles of measurement. These are divided into two general styles, contacting and non-contacting.

With the contact style, the heat sensing element is in direct contact with the object of measurement. Thermocouple, resistance, liquid filled, liquid-in-glass, and bimetal thermometers fall into this category.

In a non-contacting measurement, however, the temperature is determined by measuring the energy radiated from the object rather than making physical contact with a heat sensing element.

A variety of thermometers are available from YOKOGAWA, ranging from laboratory standards to industrial and field uses. For process applications, a separate catalog showing industrial process instrumentation including temperature indicators, recorders, and controllers is also available.

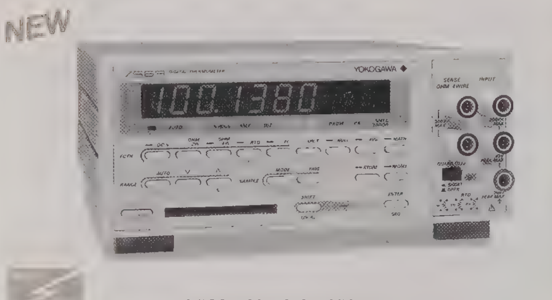
## SELECTION GUIDE

| Model | | Measuring Range (°C) | | Minimum Division or Resolution |
|---|---|---|---|---|
| | | −200 0 200 400 600 800 1,000 1,200 1,400 1,600 1,800 2,000 | | |
| **7563**<br>Digital Thermometer | R | 50 | 1,760 | 0.1°C |
| | S | −50 | 1,760 | 0.1°C |
| | B | 0 | 1,820 | 0.1°C |
| | K | −270 | 1,370 | 0.1°C |
| | J | 210 | 1,200 | 0.1°C |
| | E | 270 | 1,000 | 0.1°C |
| | T | −270 | 400 | 0.1°C |
| | U | −200 | 500 | 0.1°C |
| | L | 200 | 900 | 0.1°C |
| | N | 0 | 1,300 | 0.1°C |
| | W | 0 | 2,315 | 0.1°C |
| | KPvsAu7Fe | 0K | 300K | 0.1 K |
| | Pt100, Pt1000 | −200 | 650 | 0.01°C |
| | JPt100 | −200 | 510 | 0.01°C |
| | J263*B | 2K | 300K | 0.1 K |
| **2575**<br>Digital Thermometer | [illegible] | 0 | 1,769 | 1°C |
| | [illegible] | −100 | 1,370 | 1°C |
| | [illegible] | 100 | 1,000 | 1°C |
| | [illegible] | −100 | 1,200 | 1°C |
| | [illegible] | −100 | 230 | 0.1°C |
| **2573**<br>Portable Digital Thermometer | [illegible] | −60 | 500 | 1°C |

| Model | 7563 | 2575 | 2573 |
|---|---|---|---|
| **Number of Input** | 1 | 1 | 1 |
| **Display** | LED, 6-1/2 digits | LED 4 digits | LCD 3 digits |
| **Sample Rate** | 10 ms to 60 min | Approx. 1.5 times/s | Approx. 2 times/s |
| **Temperature Accuracy** | ±0.005% | ±0.1% | ±(2°C + 1 digit) |
| **DC Voltage Measuring Range** | 0 to ± 200 V (4 Ranges) | 0 to ±200.0 mV | |
| **Other Functions** | · Resistance measurement<br>· Mathematical functions<br>· IC memory card | · 3 way power supply<br>· Multi-channel switch available | · 2 way power supply |
| **Analog Output** | ±0.5 V, ±1 V | 1 mV/1 digit | |
| **Power Supply** | AC | AC, DC, Ni-Cd battery | AC, Ni-Cd battery |

# Digital Thermometers 7563·2575

## 7563 Digital Thermometer



**7563** 88×213×350 mm 3 kg

The 7563 Digital Thermometer accepts 16 types of temperature sensors plus measuring functions of DC V and Ω. YOKOGAWA-original A-D converter (feedback pulse width modulation method) features superior noise immunity, stability and high-speed sampling. In addition, versatile functions are suitable for system use and cover a wide variety of applications from test to R & D.

**High accuracy, high resolution and high speed sampling**
Accuracy: 0.005% (TC), 0.009% (RTD), resolution: TC...0.1°C (0.1°F), RTD...0.01°C (0.01°F), sampling rate: Max. 100 times/s (4-1/2digits).

**3 measuring functions: temperature, DC V and resistance**
TC: 12 types (R, S, B, K, E, J, T, L, U, N, W and KPvsAu7Fe), RTD: 4 types (Pt100, JPt100, Pt1000 and J263＊B).

**High-accuracy reference junction compensation: Compensation accuracy (±0.2°C)**

**IC memory card**

**GPIB or RS-232-C communication interface (standard)**

**Versatile mathematical functions**
In addition to the noise elimination by moving average function and offset compensation (NULL), a scaling function and comparator function are also available.

### DC VOLTAGE

| Range | Resolution | Accuracy: ± (% of rdg + digits) 90 days 23±5°C |
|---|---|---|
| 200 mV | 100 nV | 0.005 + 25 |
| 2 000 mV | 1 μV | 0.003 + 10 |
| 20 V | 10 μV | 0.004 + 10 |
| 200 V | 100 μV | 0.008 + 15 |

### TEMPERATURE (TC)

| *1 Range | Measurement Range | *2 Accuracy: (% of rdg + °C) 90 days, 23±5°C |
|---|---|---|
| R | −50.0 to 0°C | 0.006 + 0.5 |
| | 0.0 to 100.0°C | 0.006 + 0.4 |
| | 100.0 to 600.0°C | 0.006 + 0.3 |
| | 600.0 to 1760.0°C | 0.006 + 0.2 |
| S | −50.0 to 0°C | 0.006 + 0.6 |
| | 0.0 to 100.0°C | 0.006 + 0.4 |
| | 100.0 to 600.0°C | 0.006 + 0.3 |
| | 600.0 to 1760.0°C | 0.006 + 0.2 |
| B | 0.0 to 42.0°C | − |
| | 42.0 to 100.0°C | 0.006 + 7.0 |
| | 100.0 to 200.0°C | 0.006 + 1.5 |
| | 200.0 to 300.0°C | 0.006 + 1.0 |
| | 300.0 to 400.0°C | 0.006 + 0.7 |
| | 400.0 to 1820.0°C | 0.006 + 0.3 |
| K | −270.0 to −250.0°C | 0.005 + 1.3 |
| | −260.0 to −200.0°C | 0.005 + 0.5 |
| | −200.0 to 0.0°C | 0.005 + 0.3 |
| | 0.0 to 1370.0°C | 0.005 + 0.2 |
| J | −210.0 to −200.0°C | 0.005 + 0.4 |
| | −200.0 to −150.0°C | 0.005 + 0.3 |
| | −150.0 to 0.0°C | 0.005 + 0.2 |
| | 0.0 to 1200.0°C | 0.005 + 0.2 |
| E | −270.0 to −250.0°C | 0.005 + 0.8 |
| | −250.0 to −200.0°C | 0.005 + 0.3 |
| | −200.0 to 0.0°C | 0.005 + 0.2 |
| | 0.0 to 1000.0°C | 0.005 + 0.2 |
| T | −270.0 to −250.0°C | 0.005 + 1.0 |
| | −250.0 to −200.0°C | 0.005 + 0.3 |
| | −200.0 to 400.0°C | 0.005 + 0.2 |
| U | −200.0 to −100.0°C | 0.005 + 0.3 |
| | −100.0 to 0.0°C | 0.005 + 0.3 |
| | 0.0 to 500.0°C | 0.005 + 0.2 |
| L | −200.0 to −100.0°C | 0.005 + 0.3 |
| | −100.0 to 900.0°C | 0.005 + 0.2 |
| N | 0.0 to 1300.0°C | 0.005 + 0.2 |
| W | 0.0 to 2315.0°C | 0.005 + 0.2 |
| KPvsAu7Fe | 0.0 to 20.0K | *2 0.006 + 0.3 |
| | 20.0 to 70.0K | 0.006 + 0.2 |
| | 20.0 to 300.0K | 0.006 + 0.2 |

*1 As to the R, S, B, K, J, E and T, the provisions of JIS C1602-1981 apply. As to the U and L, those of DIN43710 apply. As to the N, those of IEC 584, DIN IEC 584 apply. As to the W, those of Hoskins Mfg Co. (USA) apply. As to the KPvsAu7Fe, those of NSB Vol. 76A apply.

*2 KPvsAu7Fe: ± (% of rdg + K)

*3 In case of accuracy of °F, multiply 1.8×°C.

### RESISTANCE (OHM)

| Range | Resolution | Accuracy (4 wire): ± (% of rdg + digits) 90 days, 23±5°C |
|---|---|---|
| 200 Ω | 100 μΩ | 0.007 + 30 |
| 2,000 Ω | 1 mΩ | 0.005 + 25 |
| 20 kΩ | 10 mΩ | 0.005 + 25 |
| 200 kΩ | 100 mΩ | 0.007 + 30 |
| 2,000 kΩ | 1 Ω | 0.03 + 150 |
| 20 MΩ | 100 Ω | 0.2 + 30 |

### TEMPERATURE (RTD)

| Range | Measurement Range | Accuracy: ± (% of rdg + digits) 90 days, 23±5°C |
|---|---|---|
| Pt100 | 200.00 to 650.00°C | 0.009 + 0.07 |
| JPt100 | 200.00 to 510.00°C | 0.009 + 0.07 |
| Pt1000 | 200.00 to 650.00°C | 0.009 + 0.05 |
| J263＊B | 2.0 to 300.0k | ± (0.011% of rdg + 0.1K) |

### AVAILABLE MODELS

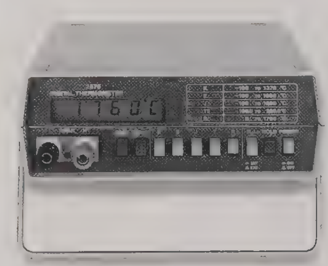
| Model | Suffix Codes | | | Description | |
|---|---|---|---|---|---|
| 756301 | ··· | ··· | ·········· | 6.5 digits | DC V, OHM, TEMP (TC & RTD) (GPIB) |
| 756302 | ··· | ··· | ·········· | | DC V, OHM, TEMP (TC & RTD) (RS-232-C) |
| | -A | ··· | ·········· | Always A (version code) | |
| Power Requirements | | -1 | ·········· | 100 V AC (50 & 60 Hz), 115 V AC changeable | |
| | | -3 | ·········· | 115 V AC (50 & 60 Hz), 100 V AC changeable | |
| | | -5 | ·········· | 200 V AC (50 & 60 Hz), 230 V AC changeable | |
| | | -7 | ·········· | 230 V AC (50 & 60 Hz), 200 V AC changeable | |
| Power Cord | | | /B ······ | JIS standard | |
| | | | /D ······ | UL standard | |
| | | | /F ······ | VDE standard | |
| | | | /G ······ | SAA standard | |
| Optional Feature | | | /DA | D/A converter | |

Standard accessories. Fuse, measuring lead, remote connector instruction manual and power supply cord

### OPTIONAL ACCESSORIES

| Name | Code |
|---|---|
| Memory card (8K bytes) | **378901** |
| Memory card (16K bytes) | **378902** |
| Memory card (64K bytes) | **378903** |

## 2575 Digital Thermometer



**257510** 60×166×207 mm 1.2 kg
(ANSI, °C model)

The 2575 is a truly portable TC thermometer for measurements from the 5 most used TC types conforming to ANSI, DIN or JIS standards. Operates on built-in rechargeable Ni-Cd battery, external 12 V DC source or line power.

**Available Models: 257510** ... ANSI or JIS (°C), **257520** ... ANSI (°F), **257530**...DIN (°C)
**Type of Display:** 4-digit LCD.
**Unit Mark:** °C or °F.
**Linearization:** Digital by ROM
**Analog Output:** Standard (1 mV/digit)
**Sampling Rate:** Approx. 1.6 times/s.
**Accessory: 281501** multi-channel switch.

**Overall Accuracy (ANSI model, at 23±3°C):**

| TC Type | Resolution | Applicable Temperature Range | Accuracy (% of rdg) |
|---|---|---|---|
| K | 1°C | −100 to 0°C | ±5°C |
| | | 0 to 1370°C | ± (0.1% + 2°C) |
| E | 1°C | −100 to 0°C | ±5°C |
| | | 0 to 1000°C | ± (0.1% + 2°C) |
| J | 1°C | −100 to 0°C | ±5°C |
| | | 0 to 1200°C | ± (0.1% + 2°C) |
| T | 0.1°C | −100 to 0°C | ±0.5°C |
| | | 0 to 230°C | ± (0.1% + 0.2°C) |
| R | 1°C | 0 to 600°C | ±5°C |
| | | 600 to 1760°C | ± (0.1% + 2°C) |
| ± 20 mV | 10 μV | ±20.00 mV | ± (0.1% + 1 digit) |
| ±200 mV | 100 μV | ±200.0 mV | ± (0.1% + 1 digit) |

## 2573 Digital Thermometer

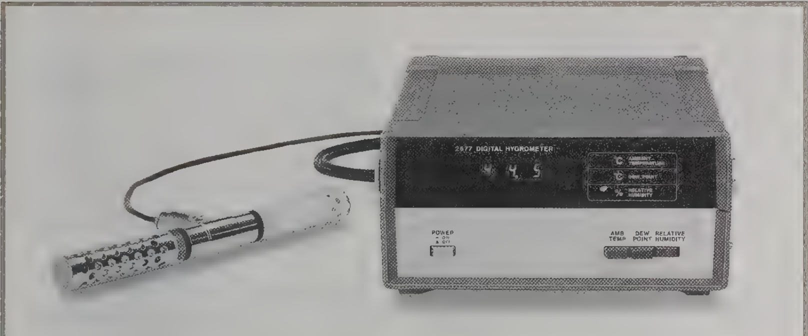
**257342** 52×142×150 mm 0.7 kg

The 2573 is used for measurement from −60 to 500°C with 1°C resolution and ±2°C accuracy. It accepts input from surface-temperature or round-tip probes, or with a terminal adapter, any K thermocouple conforming to ANSI, BS, DIN or JIS standards.

**Two Type K thermocouple probes**
**Interchangeable probes through fast, exact plug-in connection**
**Power line or rechargeable Ni-Cd battery operation**

**Temperature Sensor:** Type K probe selectable from two types (optional), or Type K thermocouple (using optional reference junction adapter).
**Temperature Range:** −60 to 500°C.
**Resolution:** 1°C.
**Accuracy:** ±(2°C +1 digit).
**Type of Display:** 3-digit LCD.
**Overrange Indication:** − − −display.
**Power Requirements:** 7.2 V Ni-Cd battery (approx. 8 hours of continuous operation with a recharging time of 16 hours) or line power (100, 120 or 220 V AC, must be specified, 50 and 60 Hz).

## 2577 Digital Hygrometer



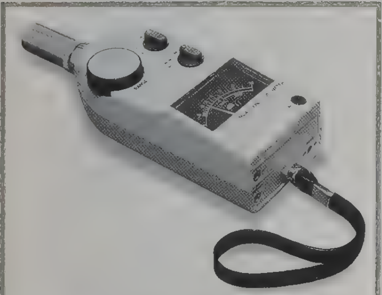
**2577** 100×210×230 mm 4.0 kg

Measures relative humidity, dew point and ambient temperature using two types of sensors. Offers many advances including portability, simple operation, analog output, excellent reliability and stability with minimum maintenance.

**Selection of 3 functions−relative humidity, dew point, ambient temperature**
**Dew point and temperature sensors in a single compact probe**
**Analog outputs**

**Measuring Ranges:** Ambient temperature...−30 to 60.0°C, dew point...−45 to 50.0°C, relative humidity...15 to 99.9%.
**Accuracy:** Ambient temperature...±0.3°C, dew point...±1°C, relative humidity...±[(7 − 0.04T)% of rdg + 0.5% of F.S.], where T is ambient temperature in °C.
**Sensor Probe:** Consists of semiconductor temperature sensor and dew point sensor (using lithium chloride solution).
**Display:** 3-digit LED.
**Reading Rate:** 2 times/s.
**Measurand:** Air.
**Power Requirements:** Rechargeable Ni-Cd battery or line power.

## 3604 Sound Level Meter



**3604** 255×88×60 mm 0.8 kg

The 3604 is a general-purpose sound level meter which measures noise level from 30 to 130 dB (A-weighted). It is designed to fulfill both national and international standardization on sound measuring equipment such as IEC Pub. 651, and JIS C1502.

**Wide dynamic range: 30 to 130 dB (A-weighted)**
**A, B and C weighting**
**Fast and slow meter damping**
**Removable condenser microphone of stable sensitivity**
**Easy-to-read bezel meter**

**Measuring Range:** 30 to 130 dB (weighting A), 40 to 130 dB (weighting B and C).
**Frequency Range:** 31.5 to 8,000 Hz.
**Attenuator:** 30 to 120 dB in 10 dB steps.
**Overall Noise Level:** Less than 25 dB (A-weighted), less than 35 dB (B- or C-weighted).
**Weighting Networks:** A, B and C.
**Meter Scale:** Graduations from −5 to +10 dB.
**Meter Damping:** Fast and Slow.
**Calibration:** Internal calibration available
**Output Voltage:** Approx. 2 V rms for full scale meter deflection.
**Output Impedance:** 600 Ω±5%
**Load Impedance:** More than 600 Ω

**Power Source:** Four 1.5 V batteries (IEC R6P, ANSI AA, Mignon 1.5 V or equivalent), or 100 V AC (50 or 60 Hz) by using an optional **B9663LA** AC Adapter (Other AC power supply voltages available upon request)
**Accessories supplied:** Windscreen... 1 pc., carrying case... 1 pc., 1.5 V batteries... (4 pcs., built-in).
**Optional Accessories:** **B9663LA** AC adapter, **362311** extension cable, **362313** microphone stand, **362305** tripod, **B9409JA** output lead.
**Microphone**
**Type:** Condenser microphone.
**Capacitance:** Approx. 30 pF.
**Maximum Allowable Input Sound Pressure Level:** 140 dB.
**Sensitivity:** −54 dB±2 dB (0 dB=1 V/μbar).

# PRESSURE MEASURING INSTRUMENTS

## Digital Manometers 2655·2661

**2655** 112×233×364 mm 6.0 kg

**2661** 112×233×364 mm 6.0 kg

The 2655 and 2661 are precision, high-resolution pressure measuring instruments which use a new tuning-fork pressure sensor. Using a new sensor and a microprocessor, both models provide convenient and stable measurement with a full range of engineering units.

**High accuracy:**
2655 (30 psi models)...±(0.03% of rdg + 0.01% of F.S.),
2661...±(0.01% of rdg + 0.01% of F.S.)

**High resolution:** 0.0001 psi or 0.00001 kg/cm² at 30 psi or 2 kg/cm² input.

**High stability with a new tuning-fork pressure sensor**

**Pushbutton-selectable engineering units**

**Quick and easy zero adjustment**

**Power line, external 12 V DC or rechargeable Ni-Cd battery operation**

**Vertical, horizontal or tilted operating position**

**Analog ouput, GPIB and RS-232-C available**

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**Pressure Sensing Element:** Tuning-fork pressure sensor and diaphragm (high-elasticity alloy EL-3).

**Applicable Fluids:** Clean, dry air or non-corrosive gases (fluid temperature should be within 5 to 50°C, or 41 to 122°F).

**Display:** 5-1/2 digit LED display.

**Resolution:** ±0.0005% of F.S.

**Sample Rate:** Approx. 0.4 s/sample.

**Response Time:** Approx. 2 s (display), approx. 0.6 s (analog output).

**Analog Output:** 2 V DC for 30 psi or 2 kg/cm² input (0.4 mV resolution), accuracy...±(0.1 % of full scale + 0.5 mV), output impedance...1 Ω max., max. current...3 mA.

**Power Requirements:** 100, 115, 200 or 230 V AC (must be specified), 50 and 60 Hz, 10 to 15 V DC , and rechargeable Ni-Cd battery (self-contained, continuously operates about six hours on a single charge).

### AVAILABLE MODELS

| Model | Pressure Range | Unit *(Connection) |
|---|---|---|
| **265511** | 3 psi, 0.2 kg/cm² (gauge) | Metric & inch (PT 1/4) |
| **265512** | 30 psi, 2 kg/cm² (gauge) | Metric (PT 1/4) |
| **265522** | 30 psi, 2 kg/cm² (gauge) | Inch (1/4 NPT) |
| **265514** | 30 psi, 2 kg/cm² (absolute) | Metric & inch (PT 1/4) |
| **266111** | 3 psi, 0.2 kg/cm² (gauge) | Metric & inch (PT 1/4) |
| **266112** | 30 psi, 2 kg/cm² (gauge) | Metric (PT 1/4) |
| **266122** | 30 psi, 2 kg/cm² (gauge) | Inch (1/4 NPT) |

***Note:** Specify pressure connection of other than the above (Refer to optional features)

### OPTIONAL FEATURES

| Suffix Codes | Name | Compatible Models |
|---|---|---|
| **/GP-IB** | GPIB interface | **2655** |
| **/RS232-C** | RS-232-C interface | **2655, 2661** |
| **/NPT4** | 1/4 NPT pressure connection | |
| **/NPT8** | 1/8 NPT pressure connection | |
| **/PT8** | PT 1/8 pressure connection | |

**Notes:** 1) Both GPIB and RS-232-C are not compatible with a single unit
2) The following models are also available upon request
- The model of rear-panel pressure connection
- The model with panel mount adapter

### OPTIONAL ACCESSORY

| Name | Part No. | Description |
|---|---|---|
| Pressure input connector | **B9310ZH** | Low-leakage, quick-change type, 1 pc. (PT 1/4 male) |

### SPARE

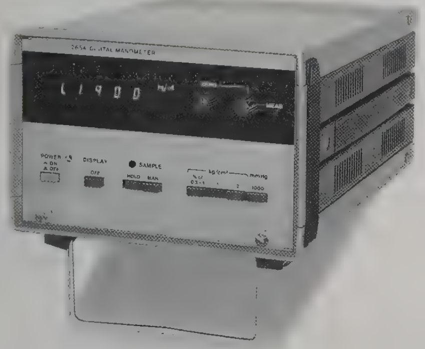
| Name | Part No. | Description |
|---|---|---|
| Ni-Cd battery | **A9042ED** | 1 pc. |

| **Model** | | **265511** | **265512** | **265522** | **265514** | **266111** | **266112** | **266122** |
|---|---|---|---|---|---|---|---|---|
| **Pressure Range (Full Scale)** | **Positive pressure** | 0 to 3 psi, 0 to 0.2 kg/cm² | 0 to 30 psi, 0 to 2 kg/cm² | | 0 to 30 psi abs., 0 to 2 kg/cm² abs. | 0 to 3 psi, 0 to 0.2 kg/cm² | 0 to 30 psi, 0 to 2 kg/cm² | |
| | **Negative pressure** | 0 to −1.5 psi, 0 to −0.1 kg/cm² | 0 to −15 psi, 0 to −1 kg/cm² | | | 0 to −1.5 psi, 0 to −0.1 kg/cm² | 0 to −15 psi, 0 to −1 kg/cm² | |
| **Accuracy** at ambient temperature of 23±2°, vertical operating position, hysteresis and linearity combined | **Positive pressure** | ±(0.04% of reading+0.01% of full scale) | ±(0.03% of reading + 0.01% of full scale) | | ±0.05% of full scale | ±(0.01% of reading + 0.01% of full scale) | | |
| | **Negative pressure** | ±(0.4% of reading + 0.1% of full scale) | | | —— | ±(0.4% of reading + 0.1% of full scale) | | |
| **Engineering Units** | | kg/cm², psi, kPa, mbar, mmHg, mmH₂O, inH₂O, inHg | kg/cm², psi, kPa, mbar, mmH₂O, mmHg, % of 0.2 to 1.0 kg/cm², % of 3 to 15 psi | psi, kPa, mbar, inH₂O, inHg, mmHg, % of 3 to 15 psi, kg/cm² | kg/cm², psi, kPa, mbar, mmHg, mmH₂O, inH₂O, inHg | | kg/cm², psi, kPa, mbar, mmH₂O, mmHg, % of 0.2 to 1.0 kg/cm², % of 3 to 15 psi | psi, kPa, mbar, inH₂O, inHg, mmHg, % of 3 to 15 psi, kg/cm² |
| **Allowable Input Pressure** | **Positive pressure** | 3.4 psi or 0 24 kg/cm² | 34 psi or 2 4 kg/cm² | | 34 psi abs. or 2 4 kg/cm² abs | 3.4 psi or 0.24 kg/cm² | 34 psi or 2 4 kg/cm² | |
| | **Negative pressure** | −1.5 psi or −0.10 kg/cm² | −15 psi or −1.0 kg/cm² | | —— | −1.5 psi or −0.10 kg/cm² | −15 psi or −1.0 kg/cm² | |
| **Fluid Leakage** | | Less than 1 cc/minute | | | Less than $10^{-5}$ cc/second | Less than 1 cc/minute | | |

Note: **265514** is zero adjusted by using an input of vacuum pump

# PRESSURE MEASURING INSTRUMENTS

## 2654 Digital Manometers



**2654** 149×233×364 mm 9.5 kg

The 2654 Digital Manometers are easy-to-handle 5-digit pressure indicators which measure pressure with an accuracy of ±0.1% or ±0.2% and with a response time of 2 s. Eliminate such inconveniences as fragile construction, restriction on operating position, troublesome mercury handling, and compensation for ambient temperature and gravity.

**Quick, easy pushbutton operation and zero adjustment**
**No temperature and gravity compensation required**
**Power line/rechargeable Ni-Cd battery operation (standard)**

**Linear analog output (standard)**
**Negative pressure measurement**
**Horizontal, vertical or tilted operating position**
**Stable pneumatic-to-voltage and A-D converters**

**Operating Principle:** Bellows pressure sensor, differential transformer (inductance) and integrating type A-D converter.
**Accuracy:** ±0.1% of F.S. (±0.2% of F.S. on 265425).
**Negative Pressure Measurement:** Available on 265423, 265424 or 265425.
**Pressure Connections:** JIS PT 1/4 (or 1/4 NPT) female.
**Max. Reading:** 11900.
**Sample Rate:** 1.5 times/s and HOLD.
**Analog Output (Standard):** +5 V DC for rated input pressure, accuracy... ±0.1% of F.S.
**Power Requirements:** 100, 115, 200, 215 or 230 V AC (must be specified), 50 and 60 Hz, built-in rechargeable Ni-Cd battery.
**Power Consumption:** Approx. 12 VA.

### AVAILABLE MODELS

| Model | Type of Measurement | Pressure Ranges | Applicable Fluids |
|---|---|---|---|
| **265421** | High gauge pressure | 10, 20 kg/cm$^2$ | Air, gases or liquids |
| **265422** | High gauge pressure | 5, 10 kg/cm$^2$ | |
| **265423** | Gauge pressure | 1, 2 kg/cm$^2$,<br>1,000 mmHg,<br>% of 0.2 to<br>1 kg/cm$^2$ | Air or gases |
| **265424** | Low gauge pressure | 1,000 mmH$_2$O,<br>2,500 mmH$_2$O | |
| **265425** | Very low gauge pressure | 250 mmH$_2$O,<br>500 mmH$_2$O | |
| **265426** | Absolute pressure | 1 kg/cm$^2$ abs.,<br>2 kg/cm$^2$ abs.,<br>1,000 mmHg abs. | |

**Note:** The models with other ranges than above are available upon request

## 2656 Pneumatic Pressure Standards

**265624** 149×233×414 mm 9.3 kg

Pressure to within 0.1% accuracy is easily available through the simple, speedy operation of four decade dials and pushbuttons. They are invaluable tools for calibration or testing of pressure-related instruments and device.

**Choice of 2 models with ±0.1% accuracy**
**Output divider dial for 20% or 25% increment output pressure setting**
**Vernier dial and offset meter**
**Quick, simple pushbutton and dial operation**
**Stable pressure-to-voltage converter**
**Compact and lightweight—portable 9.3 kg**

**Pressure Sensing Element:** Phosphor-bronze bellows.
**Source Pressure:** Clean, dry air.
**Input and Output Connections:** JIS PT 1/4 female provided on the rear panel.
**Power Requirements:** 100, 120, 200, 220 or 240 V AC (must be specified), 50 and 60 Hz.
**Power Consumption:** Approx. 30 VA

### AVAILABLE MODELS

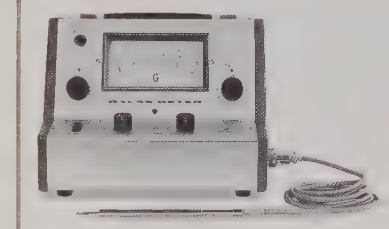
| Model | 265623 | 265624 |
|---|---|---|
| Output pressure range | 0 to 2.0000 kg/cm$^2$<br>0 to 200.00 kPa | 0 to 2500.0 mmH$_2$O,<br>0 to 25.000 kPa |
| Input (pressure) | 2.8±0.2 kg/cm$^2$ | 0.5±0.1 kg/cm$^2$ |
| Accuracy of output pressure | ±0.05% of full scale, or ±0.1% of setting (whichever is greater) | |
| Analog output (standard) | 0 to 10 mV DC for 0 to 2 kg/cm$^2$ output | 0 to 10 mV DC for 0 to 2500 mmH$_2$O |

**Note:** The models with 1/4 NPT connectors or psi gauge output are available upon request

# MAGNETIC MATERIAL TESTING EQUIPMENT

## 3251 · 3254 · 3265 to 3267

### 3251 Gauss Meter



**3251** 194×250×235 mm 5 kg

The 3251 is a portable type gauss meter which determines the magnetic flux density and polarity of magnetic poles, by using a germanium Hall generator as a magnetic field detector.

Three types of probes are available as options and are interchangeable.

Probe measuring errors can be easily calibrated with the built-in standard magnet (1 kilo-gauss).

**No full scale checking required**
**Accurate, direct response from DC to 500 Hz**
**Direct reading of magnetic fields**
From 20 to 20,000 gauss full scale in ten ranges as well as polarity
**Zero gauss chamber**
For zero gauss calibration
**Recorder and oscilloscope output**

---

**Method of Measurement:** Constant current drive system with germanium Hall generator probe.
**Measuring Range:** 20/50/100/200/500/1,000/2,000/5,000/10,000/20,000 gauss.
**Frequency Range:** DC to 500 Hz.
**Polarity Indication:** N and S polarities
**Accuracy:** ±2.5% of full scale at DC or 50 to 60 Hz.
**Output:** Recorder output ... approx. 10 mV; internal resistance... approx. 500 Ω (DC magnetic field only). Oscilloscope output ... modulated wave including 1 kHz carrier signal, appox. 0.4 Vp-p (load resistance of more than 1 kΩ).
**Power Requirements:** 100, 115, 200 or 230 V AC (must be specified), 50 and 60 Hz.
**Accessory Supplied:** Reference magnet for flat probe (1,000 gauss).....1 pc. (built in).
**Note:** Since no probe is supplied with the 3251, please specify gauss meter probe shown below when ordering the 3251.

#### OPTIONAL ACCESSORIES

**3252 Gauss Meter Probes**

| Name | Model | Dimensions of Hall Generator | Dimensions of Probe Element |
|---|---|---|---|
| Flat probe | **325201** | 0.4×3.2×8.5 (mm) | 0.15×1.2×2.5 (mm) |
| | **325202** | 0.8×3.2×8.5 (mm) | 0.15×1.2×2.5 (mm) |
| Axial probe | **325203** | 5 dia. ×105 (mm) | 1.2×2 (mm) |

**325302 External Standard Magnet**
**Magnetic Flux Density:** 1,000 gauss (for use with 325203 axial probe). Accuracy: ±0.5%

### 3254 Electronic Fluxmeter

**3254** 260×180×117 mm 2.5 kg

The 3254 measures magnetic flux cutting a search coil and is widely used for general magnetic measurements such as determining the magnetizing force of permanent magnets, flux of magnetic circuits in various types of electrical equipment (except for alternating fields) without requiring auxiliary instruments.

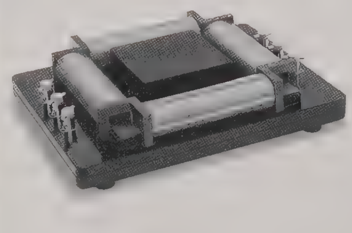
**Sensitivity to 2 kilo-Maxwell-Turns/div.**
**Stable, accurate measurements through quick and simple operation**
Low zero point drift and long indication hold time facilitates measurement of slowly-changing flux.
**Output to X-Y recorder, digital voltmeter**

**Measuring Range:** ±1×10²/3×10²/1×10³/3×10³/1×10⁴/3×10⁴/1×10⁵ kilo-Maxwell Turns.
**Scale:** −1.0 to 0 to +1.0 (100 div.)/−3.0 to 0 to +3.0 (120 div.) double graduation.
**Scale Length:** Approx. 130 mm.
**Accuracy:** ±1% of full scale length (at 23±5°C).
**Power Source:** Four 9 V batteries (IEC 6F22, Energieblock 9 V or equivalent).
**Battery Life:** Approx. 250 hours in continuous use.

#### OPTIONAL ACCESSORIES

| Name | Model | Number of Turns | Inside Area of Coil | Resistance |
|---|---|---|---|---|
| Search Coil No.1 | **325501** | 40 | 25 cm² | 2 Ω |
| Search Coil No.2 | **325502** | 100 | 6 cm² | 2 Ω |
| Search Coil No.3 | **325503** | 10 | 3 cm² | 2 Ω |

### 3265 to 3267 25 cm Epstein Iron Loss Test Sets



**3265** 390×330×145 mm 8.3 kg

The 25 cm Epstein Iron Loss Test Set is designed for determining magnetic characteristics of electrical iron sheet by means of a stack of 3 cm×30 cm long strip test specimens stacked around a 25 cm square frame. The test strips are stacked alternately on four sides of a square frame with their ends overlapping at the four corners so as to form a closed magnetic circuit. This permits determining, in combination with the appropriate indicating instruments, such important characteristics of electrical iron sheet as iron loss (at commercial or audio frequencies) and magnetizing characteristics (at commercial frequencies or DC).

**Measuring Item and Range (at 50 or 60Hz):**
**Magnetic Flux Density:** Up to approx. 17 kilo-gauss.
**Iron Loss:** 0.5 to 10 W/kg.
**Magnetizing Force:** 1 to 100 Oe.
**Permeability:** 100 to 10,000
**Test Frames:**

| Measuring Power Source Frequency | Model | Max. Weight of Test Specimen | Primary Coil | Secondary Coil | Mutual inductance |
|---|---|---|---|---|---|
| Commercial frequencies (50 or 60 Hz) | **3265** | 2 kg | 700 turns, Approx 0.6 Ω | 700 turns Approx 2 Ω | [illegible] |
| | **3266** | 0.5 kg | 700 turns, Approx 0.5 Ω | 700 turns Approx 1.5 Ω | 340 μH |
| Audio frequencies (up to 10 kHz) | **3267** | 0.2 kg | 352 turns Approx 0.4 Ω | 352 turns, Approx 0.4 Ω | [illegible] |

# Units & Conversion Factors

## FUNDAMENTAL UNITS

The International System of Units (designated as MKS for meter, kilogram, and second, or SI for Systeme International d'Unites) has been adopted by France as its only legal system of units, and similarly by the National Research Laboratory of Metrology in Japan.

Meter ·········the unit of length
Kilogram ···the unit of mass
Second ······the unit of time

Electrical units are derived from these mechanical units.

## ELECTRICAL UNITS

Watt
=unit of electric power
$=1.341\times13^{-3}$ horsepower
=amperes × volts × power factor
=0.738 foot-pounds per second

Joule, W
=work done =watts × seconds

1 kilowatthour
=3413 British thermal units
=2,654,536 foot-pounds
=860.01 kilogram-calories
$=3.671\times10^{5}$ kilogram-meters
=1.341 horsepower-hours

## CONVERSION FACTORS

These conversion factors are among those found most useful to instrument engineers. They are accurate to four or five places. Higher accuracy is almost never warranted in industrial instrumentation except in special cases.

Shown below is a set of prefixes, some of which are in common use, as in megatons, kilowatts, millivolts, and centimeters, to indicate decimal multiples and submultiples of units. These prefixes are internationally accepted.

Prefixes (Symbol)

| | | | |
|---|---|---|---|
| $10^{12}$ | tera (T) | $10^{-2}$ | centi (c) |
| $10^{9}$ | giga (G) | $10^{-3}$ | milli (m) |
| $10^{6}$ | mega (M) | $10^{-6}$ | micro ($\mu$) |
| $10^{3}$ | kilo (k) | $10^{-9}$ | nano (n) |
| $10^{2}$ | hecto (h) | $10^{-12}$ | pico (p) |
| 10 | deka (da) | $10^{-15}$ | femto (f) |
| $10^{-1}$ | deci (d) | $10^{-18}$ | atto (a) |

## LENGTH

CENTIMETERS-cm
×0.394 =Inches

FATHOMS
×6 =Feet
×1.829 =Meters

FEET-ft
×30.48 =Centimeters
×12 =Inches
×0.3048 =Meters
×1/3 =Yards

INCHES-in
×2.540 =Centimeters

METERS-m
×3.281 =Feet
×39.37 =Inches
×1.094 =Yards

MICRONS-mu or $\mu$
$\times10^{-6}$ =Meters

MILES
$\times1.609\times10^{5}$ =Centimeters
×5280 =Feet
×1.609 =Kilometers
×1760 =Yards

## WEIGHT

DRAMS-dr
×27.34 =Grains
×0.0625 =Ounces
×1.772 =Grams

DRAINS, Avoirdupois or Troy
Grains avoirdupois
=Grains troy
×0.0648 =Grams

GRAMS-g
×980.7 =Dynes
×15.43 =Grains
×0.03527 =Ounces
×0.03215 =Ounces (troy)
$\times2.205\times10^{-3}$ =Pounds

KILOGRAMS-kg
×2.205 =Pounds
$\times1.102\times10^{-3}$ =Tons (short)

OUNCES-oz
×16 =Drams
×437.5 =Grains
×0.06250 =Pounds
×28.35 =Grams
×0.9115 =Ounces (troy)
$\times2.790\times10^{-5}$ =Tons (long)
$\times2.835\times10^{-5}$ =Tons (metric)

POUNDS-lb
×16 =Ounces
×256 =Drams
×7000 =Grains
$\times5\times10^{-4}$ =Tons (short)
×453.6 =Grams
×1.215 =Pounds (troy)

TONS, Metric (Tonne, Millier)
×1000 =Kilograms
×2204.6 =Pounds

## VOLUME

CUBIC CENTIMETERS-cu cm or $cm^3$
$\times3.5315\times10^{-5}$ =Cubic feet
$\times6.102\times10^{-2}$ =Cubic inches
$\times1.308\times10^{-6}$ =Cubic yards
$\times2.642\times10^{-4}$ =Gallons
$\times2.200\times10^{-4}$ =Gallons (Imperial)
$\times1.000\times10^{-3}$ =Liters

CUBIC FEET-cu ft
$\times2.832\times10^{4}$ =Cubic centimeters
×1728 =Cubic inches
×0.02832 =Cubic meters
×0.03704 =Cubic yards
×7.481 =Gallons
×6.229 =Gallons (Imperial)
×28.32 =Liters

CUBIC INCHES-cu in
×16.39 =Cubic centimeters
$\times5.787\times10^{-4}$ =Cubic feet
$\times1.639\times10^{\ 5}$ =Cubic meters
$\times2.143\times10^{-5}$ =Cubic yards
$\times4.329\times10^{-3}$ =Gallons
$\times3.605\times10^{-3}$ =Gallons (Imperial)
$\times1.639\times10^{-2}$ =Liters

CUBIC METERS-cu m or $m^3$
×35.31 =Cubic feet
×61.024 =Cubic inches
×1.308 =Cubic yards
×264.2 =Gallons
×220.0 =Gallons (Imperial)
×1000.0 =Liters

CUBIC YARDS-cu yd
$\times7.646\times10^{5}$ =Cubic centimeters
×27 =Cubic feet
×46,656 =Cubic inches
×0.7646 =Cubic meters
×202.0 =Gallons
×168.2 =Gallons (Imperial)
×764.6 =Liters

GALLONS-gal
×8.322 =Pounds of water
(at 20°C or 68°F in air)
×3785 =Cubic centimeters
×0.1337 =Cubic feet
×231 =Cubic inches
$\times3.785\times10^{-3}$ =Cubic meters
$\times4.951\times10^{-3}$ =Cubic yards
×0.8327 =Gallons (Imperial)
×8 =Pints (liquid)
×3.785 =Liters

LITERS-ℓ
×1000.0 =Cubic centimeters
×0.035315 =Cubic feet
×61.02 =Cubic inches
$\times1.308\times10^{-3}$ =Cubic yards
×0.2642 =Gallons
×0.2200 =Gallons (Imperial)

## TEMPERATURE

Degrees Celsius-°C
C+273.15 =K Kelvin
(C×9/5)+32=F Fahrenheit
C×4/5 =R Réaumur

Degrees Fahrenheit-°F
F+459.67 =Rankine
(F-32)×5/9 =C Celsius
(F-32)×4/9 =R Réaumur

Degrees Réaumur-°R
R×5/4 =C Celsius
(R×9/4)+32=F Fahrenheit

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# SALES/SERVICE OFFICES & REPRESENTATIVES

## NORTH AMERICA

### U.S.A.

**YOKOGAWA CORPORATION OF AMERICA HEADQUARTERS AND PLANT**
2 Dart Road,
Shenandoah Industrial Park,
Newnan, Georgia 30265
Tel: 404-253-7000
Fax: 404-251-2088 (Sales & Adm.)
Fax: 404-251-7327 (Cust. Svc & Procurement)

### CANADA

**R.H. NICHOLS CO. LTD.**
80 Vinyl Court,
Woodbridge, Ontario L4L 4A3
Tel: 416-851-8871
Fax: 416-851-6862

**C.B. ENGINEERING LTD.**
#1, 6320-11 Street South East,
Calgary, Alberta T2H 2L7
Tel: 403-259-6220
Fax: 403-259-3377

## CENTRAL & SOUTH AMERICA

### ARGENTINA

**HERTIG S.A.**
Bolivar 1335, (1141) Buenos Aires
Tel: 1-361-7136
Telex: 25739 HERT AR

### BRAZIL

**YOKOGAWA ELETRICA DO BRASIL IND. E COM. LTDA.**
Praça Acapulco, 31-CEP 04675 Santo Amaro,
São Paulo
Tel: 11-548-2666
Fax: 11-522-5231
Telex: 1157755-YOKO-BR

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# LR 8100 RECORDERS

## Advanced, Intelligent 250mm Recorders with up to 8 Channels....

accept DC V, 12 types of TC's and RTD's

YOKOGAWA

Bulletin 3701-E

# Programmable, High Performance Lineup with Simple & Quick Operation.

The LR8100 is a new intelligent 250 mm recorder lineup including 4-, 6- and 8-channel models. All models handle a wide range of input types—DC voltage, 12 types of thermocouples and four types of resistance bulbs for each channel. In addition to clear, highly-readable color traces by using a new recording mechanism, LR8100 also provides versatile alphanumeric printout functions such as digital data printout, scale markings, alarms, message and program list printout. Notwithstanding its high performance and many advanced functions of inputs, display, programming and recording/printout, operation of LR8100 is very simple merely by depressing the front-panel keys and rotating knob with conversational programming on its display.

## LR 8100

## A Full Line of Convenient Features

- **4-, 6-, 8-channel models**

- **A wide range of input types**

A single instrument accepts the inputs of DC V, 12 types of TC's (ANSI, DIN, JIS) including a cryogenic TC of KP vs Au7Fe (NBS), and 4 types of RTD's including a YOKOGAWA-original cryogenic RTD of J263*B (platinum and rare cobalt).

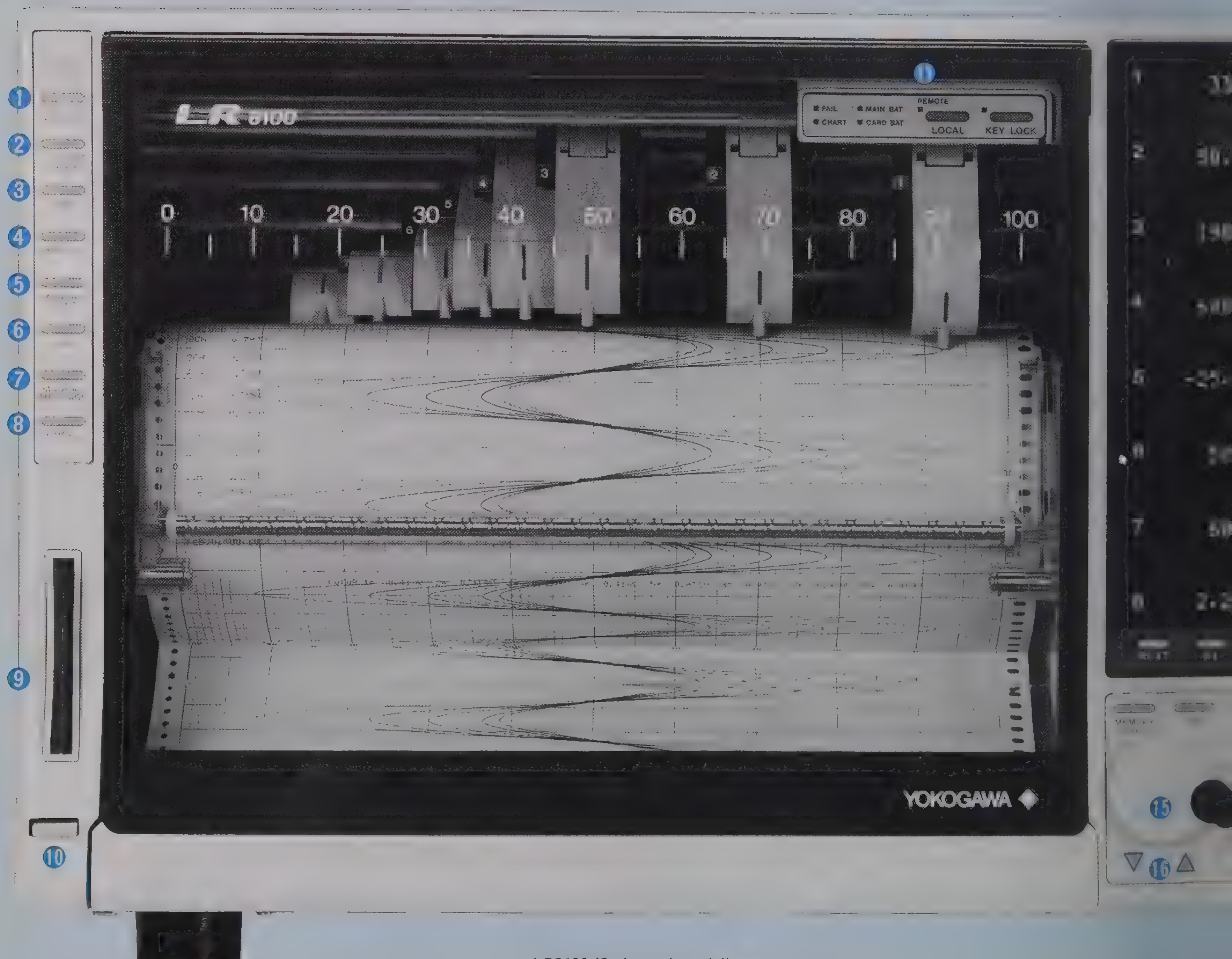
- **New recording mechanism for long-term clear, distinct color traces**

New recording system features the chart length of 30 m (98 ft), and total trace length of about 1,500 m (4,900 ft) without blotting and smudge.

- **High pen speed — 1,600 mm/s max.**

- **Versatile alphanumeric printout modes**

Full selection of alphanumeric printout modes include



*LR8100 (8-channel model)*

# Multifunction through a Wide Range of Standard & Optional Features.

measured data, scale markings, alarms, message, manual, program list, and more.

- **Zone (RECORD AREA ADJ) and partially expanded-scale recording, and AUTO SPAN SHIFT mode**

Highly diverse recording of Zone, partially expanded-scale and AUTO SPAN SHIFT are selectable for each channel. On AUTO SPAN SHIFT mode, recording span is automatically shifted to ±50%, and recording continues when the input exceeds the measuring span.

- **A choice of 3 display modes—Digital data, bar graph or range data display**

- **Standard or optional memory card**

Standard memory card is used for storing panel setting data, while optional memory card, for storing measured and panel setting data with memory capacity of 256K bytes.

- **Wide voltage range power supply of 90 to 250 VAC**

- **Simple, quick operation with conversational setting on VFD (Vacuum Fluorescent Display)**

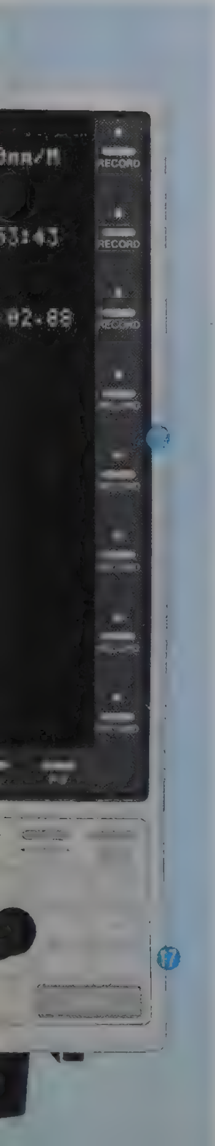
- **Compact and lightweight—18 kg (39.7 lbs) on 8-channel model**

- **Exceptionally high reliability through the use of non-contact digital servo mechanism with compact, brushless DC servomotors**

- **GPIB or RS-232-C interface (optional)**

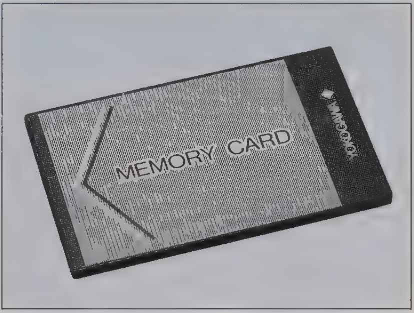
An optional feature of either GPIB or RS-232-C can handle data output and panel setting data. Analog recording of digital inputs is also available through the computer interface.

- **A wide range of optional features — Mathematical functions, remote controls, alarms, DC power source and °F display**

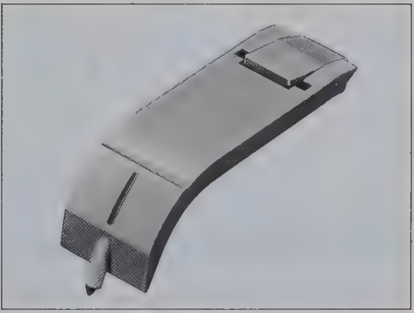


## Panel Layout & Functions

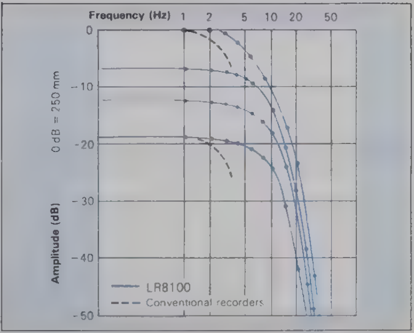
① **DISPLAY SELECT:** Selects the display (measured data, bar graph or range).
② **CHART START:** Starts the chart drive.
③ **FEED:** Feeds the chart at a touch of this key.
④ **PEN LIFT:** Lifts or lowers all the pens simultaneously.
⑤ **MANUAL PRINT:** Prints out measured data in a single line.
⑥ **LIST:** Used for program list printout.
⑦ **MANUAL MESSAGE:** Starts to print the message of up to 70 characters.
⑧ **POC:** Pen offset compensation ON/OFF key.
⑨ **Memory card slot**
⑩ **Power ON/OFF key**
⑪ **Alarm & remote indicators**
**FAIL:** Lights up in fail condition.
**CHART:** Lights up before out-of-chart condition.
**MAIN BAT:** Lights up to indicate low battery (mainframe).
**CARD BAT:** Lights up to indicate low battery (memory card).
**REMOTE/LOCAL:** For setting GPIB remote/local (optional).
**KEY LOCK:** Used for locking ⑬ to ⑰ key entries.
⑫ **RECORD:** Recording ON/OFF keys for each channel.
⑬ **Function keys**
**NEXT:** Selects to the next menu on display.
**F1 to F4:** Function keys for menu setting.
⑭ **Function keys**
**MEMORY CARD:** For setting the memory card.
**AUX:** For setting alarms, tag number message and clock.
**RECORD AREA ADJ:** For setting recording span for each channel.
**ZERO SPAN:** Used for zero adjustment or change of recording span.
**RANGE:** For setting measuring range.
**CHART SPEED:** For setting chart speed.
⑮ **Menu setting knob:** Displays menu setting of range and chart speed.
⑯ **Cursor keys:** Shift the cursor on screen up and down.
⑰ **Alphanumeric keys:** 18-key setting key pads.
**ENTRY:** Depress to make entry setting.



*Memory card*

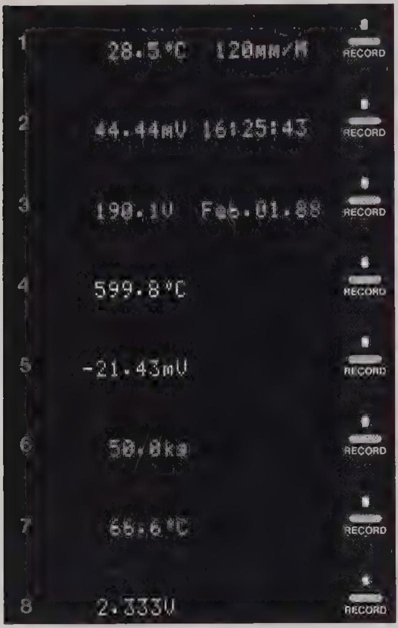


*Disposable felt-tip pen cartridge*

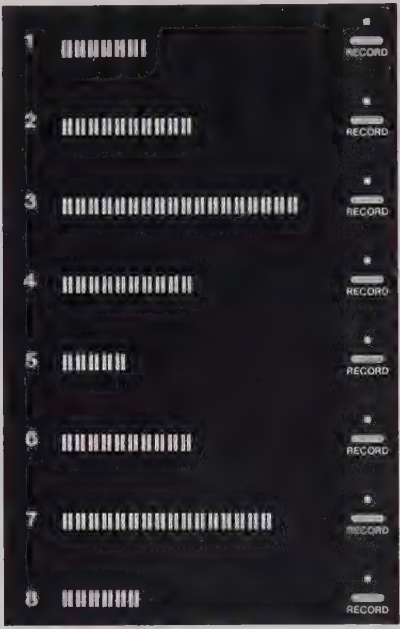


*Frequency characteristics*

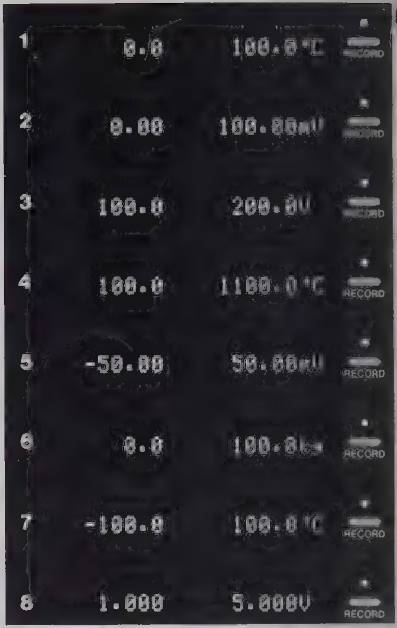
# Simplified Operation with Conversational Setting on Easy-to-Read Display.


1 28.5°C 120mm/M
2 44.44mV 16:25:43
3 190.1V Feb.01.88
4 599.8°C
5 -21.43mV
6 50.0kg
7 66.6°C
8 2.333V

*Measured data display*



*Bar graph display*


1 0.0 100.0°C
2 0.00 100.00mV
3 100.0 200.0V
4 100.0 1100.0°C
5 -50.00 50.00mV
6 0.0 100.0kg
7 -100.0 100.0°C
8 1.000 5.000V

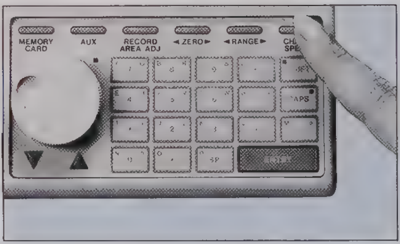
*Range data display*

## Examples of Setting & Display

**LR8100** features simple menu setting with interactive display. Following three steps are the examples of chart speed setting:

**STEP 1**

**CHART SPEED key (function key)**
Depress to display the chart speed.



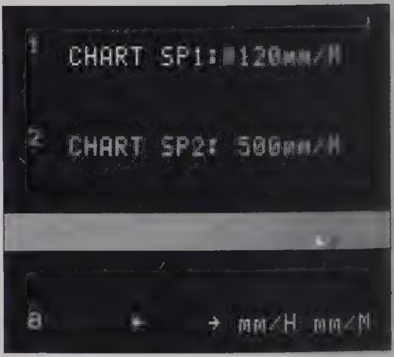
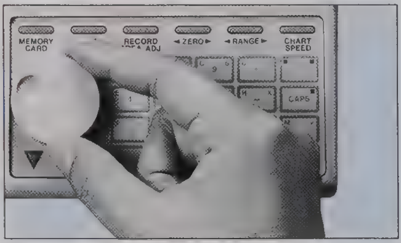
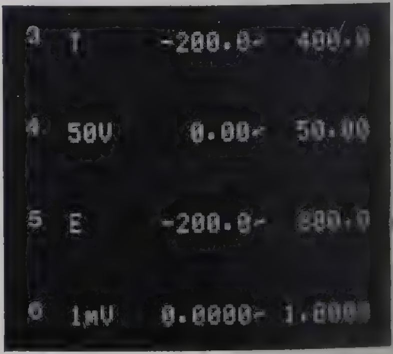

1 CHART SP1: 120mm/M
2 CHART SP2: 500mm/M
8 ← → mm/H mm/M

*Chart speed setting display*

**STEP 2**

**Menu setting knob**
By rotating this knob, 17 chart speeds (in mm or inch) are alternatery displayed. Other chart speeds can also be programmed in 1 mm or 1 inch steps via alphanumeric key operations.

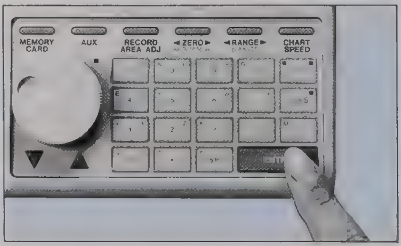



3 T -200.0~ 400.0
4 50V 0.00~ 50.00
5 E -200.0~ 800.0
6 1mV 0.0000~ 1.0000

*Range setting display*

**STEP 3**

**ENTRY key**
Depress ENTRY key (end of setting).



# Specifications

## MEASUREMENTS

**Drive System:** Automatic null-balancing digital servo mechanism with brushless DC servomotor.

**Type of Input:** Floating, guarded and shielded (No guard on 10 mV F.S. model).

**Input Types & Measuring Ranges:** DC V... 10 mV to 200 V F.S., 1 mV to 200 V F.S., or 0.1 mV to 200 V F.S.
TC (ANSI, DIN, JIS)...Type R, S, B, K, E, J, T, N, W, L (DIN), U (DIN).
TC (NBS)...KP vs Au7Fe (4 to 280K).
RTD...Pt100 (1mA), JPt100(1mA), Pt50 (1mA), Ni100 (1mA), J263∗B, Pt100: JISC 1604-1989, JISC 1606-1989,: DIN IEC 751, IEC 751, JPt100: JISC 1604-1989, JISC 1606-1989, Pt50: JISC 1604-1981, JISC 1606-1986, Ni100: DIN, SAMA

**Accuracy:** DC V...±(0.05% of rdg + 0.03% of range + 0.5 μV).
TC...±(0.05% of rdg + 0.5°C) for K, E, J, T, L, U and KP vs Au7Fe, ±(0.05% of rdg + 1°C) for R, S and B, ±(0.1% of rdg + 0.5°C) for N, ±(0.1% of rdg + 1°C) for W.
RTD...±(0.05% of rdg + 0.2° C) for Pt100 1 JPt100 and Ni100, ±(0.05% of rdg + 0.3° C) for Pt50 and J263∗B. (at 23±2° C, 55±10% R.H.).

**Reference Junction Compensating Accuracy (TC):** ±0.5°C for K, E, J, T, N, W, L, U and KP vs Au7Fe, ±1°C for R, S and B (measuring range of down to −100°C).

**Bias Current:** 4 nA.

**Filter:** 0.1, 1 Hz or OFF (selectable).

**Zero Set:** Adjustable.

**Measuring Cycle:** 135 Hz.

**Pen Offset Compensation (Standard):** Average, max./min. recording selectable (with compensation ON/OFF switch), resolution on time axis... 0.05 mm, automatic sweep function for pen offset data, and selectable POC (pen offset compensation) reference pen.

**Input Impedance:** Approx. 1 MΩ (DC V & TC).

**Allowable Source Resistance:** Less than 1 kΩ (DC V & TC).

**Temperature Coefficient:** ±0.05% of F.S./°C.

**Maximum Allowable Input Voltage:** 250 V DC.

**Maximum Common Mode Voltage:** 250 Vrms AC.

**Commom Mode Rejection:** More than 150 dB at AC.

**Normal Mode Rejection:** More than 50 dB at 50 or 60 Hz.

## RECORDING & PRINTING

**Writing & Printing System:** Ink writing using disposable felt-tip pen cartridges (analog data), and wire-dot printer using ribbon cassette (digital data).

**Effective Recording Span:** 250 mm (analog data).

**Pen Offset between Channels:** Approx. 4 mm on the time axis.

**Number of Channels:** 4, 6 or 8.

**Recording Colors:**

| 1st | 2nd | 3rd | 4th | 5th | 6th | 7th | 8th |
|---|---|---|---|---|---|---|---|
| Red | Green | Blue | Brown | Black | Purple | Orange | Violet |

**Recording Accuracy:** Measurement accuracy + ±0.2% of effective recording span (including non-linearity, deadband and error between ranges).

**Maximum Pen Speed:** Approx. 1,600 mm/s.

**Maximum Acceleration:** Approx. 8 G.

**Printing Rate:** Approx. 1.5 s/line.

**Chart:** Z-fold chart (270 mm x 30 m).

**Chart Speeds:** 10 to 1,200 mm/min & mm/h (1 mm steps), and 0.5 to 45.0 inch/min & inch/h (0.1 inch steps).

**Change of Chart Speed:** Changes chart speed with remote control signals (optional).

**RECORD ON/OFF Selectors:** Independently provided for each channel on the front panel (ON... measurement/recording, OFF... measurement).

**Pen Lift:** All pens are simultaneously lifted and lowered.

**Chart Drive:** Pulse motor drive.

**Chart Speed Accuracy:** ±0.1% (at recording of longer than 1 m).

**Digital Data Printout:** Time, chart speed, channel number (tag number), measured data and engineering unit are printed out at the following intervals:

| Chart speed | | Printing intervals |
|---|---|---|
| mm/min | mm/h | |
| 1,200 to 300 | – | 1 min |
| 299 to 30 | – | 10 min |
| 29 to 10 | 1,200 to 120 | 1 h |
| – | 199 to 60 | 2 h |
| – | 59 to 40 | 3 h |
| – | 39 to 20 | 6 h |
| – | 19 to 10 | 12 h |

**Tag Number Printout:** Tag number can be printed out in place of channel number (up to 7 alphanumerics).

**Alarm Printout:** Channel number, alarm type, and the time of alarm ON/OFF are printed.

**Scale Markings Printout:** 0% and 100% scale values can be printed out.

**Program List Printout:** Contents of entire setting memory can be listed on the chart.

**Manual Printout:** Time and measured data for all channels can be printed out in a single line by a push of MANUAL PRINT key.

**Message Printout:** Message of up to 70 characters can be printed at a push of MANUAL MESSAGE key (Message 0), or by external contact signal (Message 1 to 4; optional, up to 4 channels).

**Change of Chart Speed Printout:** Chart speed and time can be printed out at the change of chart speed.

**Pen Offset Compensation ON/OFF Printout:** ON, OFF mark and time can be printed out.

**Change of Range Printout:** Range chenges and time can be printed at the change of range (on Auto recording span shift mode).

**Partially Expanded-Scale Recording:** Any portion within full scale can be expanded or reduced for each channel.

**Auto Recording Span Shift Mode:** Automatically shifts to ±50% of span, and recording continues when the input exceeds the measuring span.

**External Input Span:** Small error of external converter can be corrected by setting the span with actual input voltage (zero...span left, full...span right).

## DISPLAY

**Type of Display:** Vacuum fluorescent dispqay(5×7 dot matrix, blue), 20 characters for each channel.

**Display Modes:** 3 display modes can be selected at a push of DISPLAY SELECT key; Digital data display . . . Measured data (7 digits), date and time, and chart speed, Bar graph display (2.5% resolution), Range data display.

## ALARMS

**Number of Alarm Set Levels:** UP to 2 levels/channel.

**Alarm Types:** High(H), low(L), delta high(dH), and delta low (dL).

**Alarm Outputs (Optional):** Up to 8 points (internal, contact rating . . . 24 V AC 1A

## COMPUTING FUNCTIONS

**Standard Functions:** Scaling (ranges . . −22000 to +22000), and ΔT.

**Optional Mathematical Functions:** +, −, ×, ÷, Square root, absolute value, logarithm, exponential function (up to 8 channels).

## GENERAL SPECIFICATIONS

**Standard Memory Card:** For storing setting data (memory capacity of 8K bytes), standard accessory . . . lithium battery, 1pc. (battery life of about 5 years).

**Battery-Backup Memory:** Maintains all setting for about 10 years(at room temperature)when power is removed.

**FAIL Alarm:** FAIL LED lights up when the instrument is in fail condition (FAIL output; optional).

**Chart END Alarm:** CHART LED lights up before out-of-chart condition, and recording stops (alarm output, optional).

**Mounting:** Desk-top or flush panel mounting (may be inclined up to 30°backward from vertical).

**Operating Temperature Range:** 0 to 40°C(32 to 104°F).

**Humidity Range:** 30 to 80% relative humidity.

**Insulation Resistance:** More than 100 MΩ at 500 V DC betwees power line and case, and between input terminals and case.

**Dielectric Strength:** 1,500 V AC for one minute between power line and case.

**Power Requirements:** Wide voltage range power supply from 90 to 250 V AC, for both 50 and 60 Hz.

**Power Consumption:** 4-channel model . . . 130 VA max., 70 VA balanced, 6-channel model . . . 160 VA max., 85 VA balanced, 8-channel model . . . 190 VA max., 100 VA balanced.

**Dimensions:** Approx. 266 (H)×438 (W)×310 (D) mm, 10-1/2×17-1/4×12-1/4″ .

**Weight (Approx.):** 4-channel model . . . 16kg (35.3 lbs), 6-channel model . . . 17.5kg(38.6 lbs), 8-channel model . . . 18 kg(39.7 lbs).

## OPTIONAL FEATURES

### ■ GPIB INTERFACE(/GP-IB)

**Functional, Electrical and Mechanical Specifications:** Meets the IEEE Standard 488-1978.

**Talker Functions:** Input of measured data(ASCII), output of measured data(ASCII and binary), input/output of setting data(ASCII), output memory data(ASCII) and binary).

**Listener Functions:** Controls except for power ON/OFF, key lock ON/OFF and chart drive.

### ■ RS-232-C INTERFACE(/RS232C)

**Functional, Electrical and Mechanical Specifications:** Meets the EIA RS-232-C.

**Controller Interface Functions:** Input of measured data (ASCII), output of measured data(ASCII and binary), input/output of setting data(ASCII), output of memory data(ASCII and binary).

**Data Transfer Rates:** 75, 150, 300, 600, 1, 200.2, 400, 4, 800, 9, 600, bps

### ■ REMOTE CONTROLS(/REM)

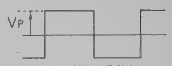
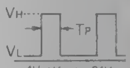
**Remote Control Signals:** External contact, open collector or TTL-level signal.

**Chart Drive Control:** Chart drive start/stop.

**Change of Chart Speed:** Selectable chart speed 1 or 2.

**Manual Printout :** Printout date&time and meanured data

**Chart Speed:**

| Remote cotrol signal waveforms | Sine, triangular, rectagular waves | Pulse train |
|---|---|---|
| Signal level |  <br>$4V < V_P < 24V$ |  <br>$+4V < V_H < +24V$<br>$-24V < V_L < +0.5V$<br>$T_P > 300\mu s$ |
| Max, signal source impedance | 600Ω | 50Ω |
| Chart speed | 0.15f cm/min(f . . . Hz or pps) | |
| Max. frequency | 800Hz | 800PPS |

**Message Printout :** Printout time and message (up to 70 characters, 4strokes).

**Pen Lift :** All recording pens lowered and lifte.

**RECORD ON/OFF Selection:** OFF (measurement) and ON (measurement/recording).

**External Trigger:** Start . . . write to memory card (optional).

### ■ ALARMS(/AK-04)

**Number of Outputs:** 4points(internal).

**Contact Rating:** 24 V DC and AC 1A.

**Outputs:** Alarm, FAIL alarm and chart END alarm outputs.

### ■ DC power source(/DC)

**Normal operating voltage:** 10 to 32 V DC.

**Power consumption:** 60 VA (average value).
200 VA (maximum).

**Accessories:** Connector(1pc.), fuse(1pc.).

## OPTIONAL ACCESSORY

### ■ SETTING&MEASURED DATA MEMORY (378904)

**Data Format:** MS-DOS.

**Sampling Rate:** Free mode(manual start) . . . 135, 9, 5, 3, 1, 0.5, 0.2Hz, trigger mode(starts by trgger conditions) . . . 135, 9, 5, 3, 1, 0.5, 0.2Hz.

**Memory Capacity:** 256K bytes.

**Data Length:** 1,000, 2,000, 4,000, 8,000, 16,000, 32,000 data/channel(common setting to each channel, 2bytes/data)

**Trigger Condition:** Alarm detection, CHART END or external contact input(optionl).

**Pre-Trigger:** 0 to 100%(10% steps).

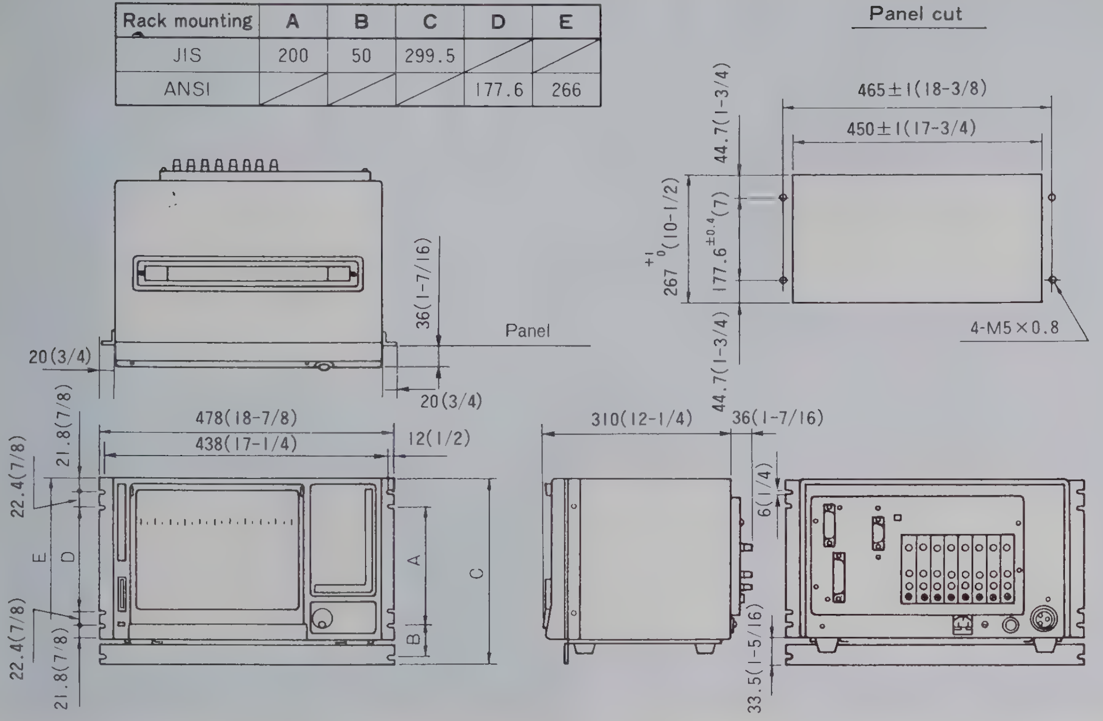
**Memory Data:** Meanured data, interface input data and computed data.

**Output:** Communication interface and recording output.

# Dimensions

Unit: mm (approx. inch)

| Rack mounting | A | B | C | D | E |
|---|---|---|---|---|---|
| JIS | 200 | 50 | 299.5 | | |
| ANSI | | | | 177.6 | 266 |



## Model and Suffix Codes

| Model | Suffix Codes | Description | | |
|---|---|---|---|---|
| 3701 | ........................ | LR8100 Recorder | | |
| | | No. of Channels | Input Types | Max. Sensitivity |
| No. of channels, input types & max. sensitivity | 41 ........................ | 4 | DC V, TC | 10mV F.S. |
| | 42 ........................ | 4 | | 1mV F.S. |
| | 43 ........................ | 4 | | 0.1mV F.S. |
| | 44 ........................ | 4 | DC V, TC, RTD | 10mV F.S. |
| | 45 ........................ | 4 | | 1mV F.S. |
| | 46 ........................ | 4 | | 0.1mV F.S. |
| | 61 ........................ | 6 | DC V, TC | 10mV F.S. |
| | 62 ........................ | 6 | | 1mV F.S. |
| | 63 ........................ | 6 | | 0.1mV F.S. |
| | 64 ........................ | 6 | DC V, TC, RTD | 10mV F.S. |
| | 65 ........................ | 6 | | 1mV F.S. |
| | 66 ........................ | 6 | | 0.1mV F.S. |
| | 81 ........................ | 8 | DC V, TC | 10mV F.S. |
| | 82 ........................ | 8 | | 1mV F.S. |
| | 83 ........................ | 8 | | 0.1mV F.S. |
| | 84 ........................ | 8 | DC V, TC, RTD | 10mV F.S. |
| | 85 ........................ | 8 | | 1mV F.S. |
| | 86 ........................ | 8 | | 0.1mV F.S. |
| Version-up model | -B ................ | | | |
| Power requirements | -0 ................ | 90 to 250 VAC | | |
| Optional features | /GP-IB | GPIB interface | | |
| | /RS232C | RS-232-C interface | | |
| | /MATH | Mathematical functions | | |
| | /AK-08 | Alarms (internal, 8 points) | | |
| | /REM | Remote controls | | |
| | /DF | °F display | | |
| | /DC | DC power source operation | | |

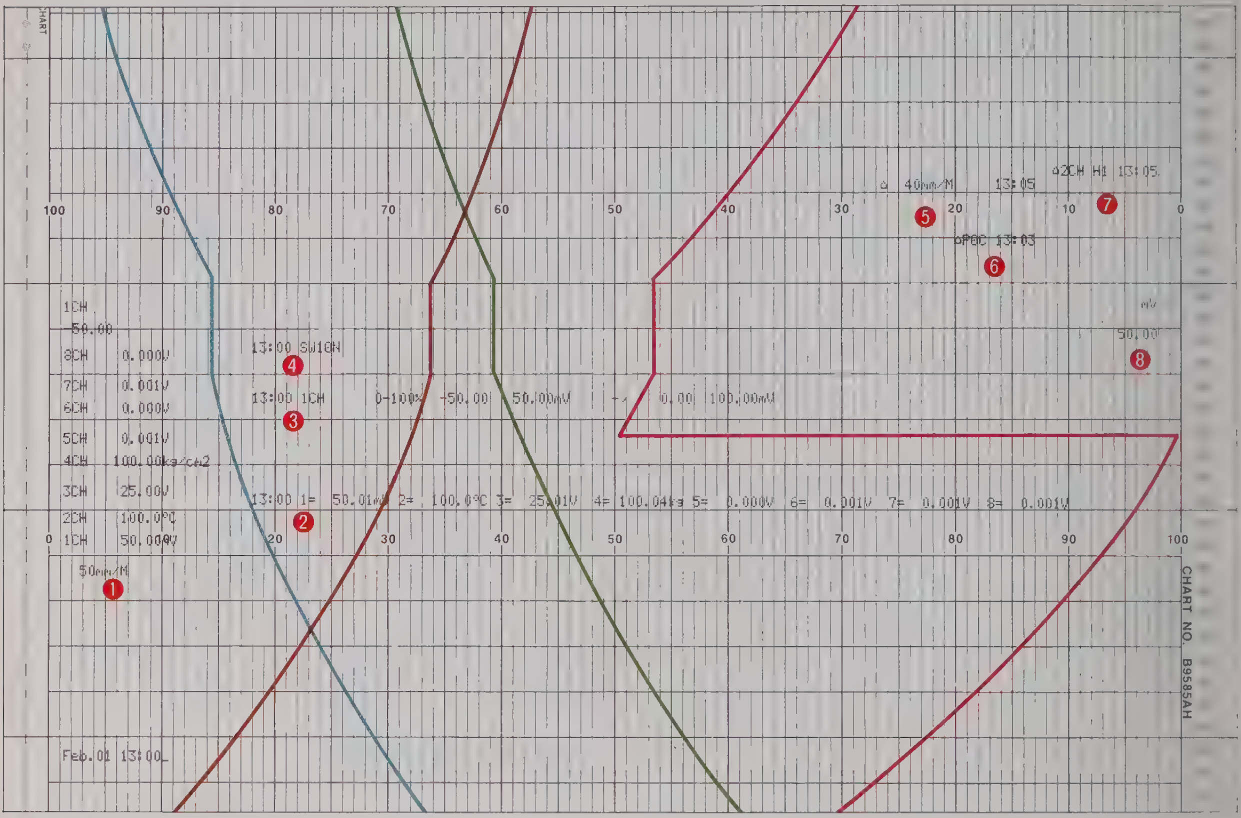
## Accessories & Spares

| Name | | Standard accessories | | | Spares | |
|---|---|---|---|---|---|---|
| | | 4-channel | 6-channel | 8-channel | Part No. | Order Q'ty |
| Ribbon cassette | | 1 pc. | 1 pc. | 1 pc. | B9585SH | 1 unit (1 pc./unit) |
| Z-fold chart (270mm x 30m) | | 1 chart | 1 chart | 1 chart | B9585AH | 10 units (1 chart/unit) |
| *Disposable felt-tip pen cartridge | 1st channel (red) | – | – | – | B9586□A | 1 unit (3 pcs./unit) |
| | 2nd channel (green) | – | – | – | B9586□B | |
| | 3rd channel (blue) | – | – | – | B9586□C | |
| | 4th channel (brown) | – | – | – | B9586□D | |
| | 5th channel (black) | – | – | – | B9586□E | |
| | 6th channel (purple) | – | – | – | B9586□F | |
| | 7th channel (orange) | – | – | – | B9586□G | |
| | 8th channel (violet) | – | – | – | B9586□H | |
| | 1st to 4th channels | 1 pc. each | – | – | B9586□R | 1 unit (1 pc. each /unit) |
| | 1st to 6th channels | – | 1 pc. each | – | B9586□S | |
| | 1st to 8th channels | – | – | 1 pc. each | B9586□T | |
| Memory card (setting data), 8K bytes | | 1 pc. | 1 pc. | 1 pc. | 378901 | 1 unit (1 pc./unit) |
| Memory card (setting & measured data), 256K bytes | | – | – | – | 378904 | |
| Lithium battery (for mainframe) | | 1 pc. | 1 pc. | 1 pc. | B9588ZB | |
| Lithium battery (for 378901) | | 1 pc. | 1 pc. | 1 pc. | B9586JU | 2 units (1 pc./unit) |
| Lithium battery (for 378904) | | – | – | – | B9586JV | |
| Dust cover | | – | – | – | B9585AY | 1 pc. |
| Measurement leads (1m) | | – | – | – | B9409JA | 1 set |
| Power cord (2- or 3-prong type) | | 1 set | 1 set | 1 set | Order by name | |
| Fuse | | 1 pc. | 1 pc. | 1 pc. | Order by name | |
| Rack adapter (ANSI & JIS) | | – | – | – | 378981 | 1 set |

*Note: Specify one of code (**X**, **Y** or **Z**) in □.
**Y** ... Standard (pen speed of lower than approx. 800mm/s).
**Z** ... High speed (pen speed of higher than approx. 800mm/s).
**X** ... Low speed (chart speed of lower than approx. 100mm/h).

# Maximum Flexibility in Analog Recording/ Digital Printout.

An Example of Recording/Printout



① **Digital Data Printout:** Digital data are printed out at regular time intervals (1 min min.) corresponding to chart speed.

② **Manual Printout:** When MANUAL PRINT key is depressed, digital data of time and measured data for all channels are printed out in a single line.

③ **Change of Range Printout:** When range is changed, time, old and new ranges are printed out.

④ **Message Printout:** The time and message (up to 70 characters) can be printed by depressing MANUAL MESSAGE key, or by external contact signal.

⑤ **Change of Chart Speed Printout:** When chart speed is changed, new chart speed and time can be printed.

⑥ **Pen Offset Compensation ON/OFF Printout:** ON (△POC) or OFF (▽POC) and time are printed out.

⑦ **Alarm Printout:** Channel number, alarm type and time of alarm ON/OFF are printed.

⑧ **Scale Markings:** Scale values of 0% and 100% are printed at regular intervals corresponding to chart speed.

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# LR 4200 RECORDERS

## Easy-to-Operate Flatbed Pen Recorders with up to 4 Channels....

**accept DC V, 12 types of TC's and RTD's**

YOKOGAWA

Bulletin 3721-E

# Multifunction with Easy-to-Operate Keyboards.

## LR 4210

(With printer & electrical pen lift)

## A Full Line of Convenient Features

- **A wide range of input types**
  A single instrument accepts the inputs of DC V, 12 types of TC's (ANSI, DIN, JIS) including a cryogenic TC of KP vs Au7Fe (NBS), and 4 types of RTD's including a YOKOGAWA-original cryogenic RTD of J263*B (platinum and rare cobalt).
- **Versatile alphanumeric printout modes (LR4210)**
  Full selection of alphanumeric printout modes include measured data, date & time, scale markings, alarms, message, manual, program list and more.
- **A choice of 3 display modes — Measured data, bar graph, or range data display**
- **Zone recording**
  Recording position can be set for each pen in % basis
- **Partially expanded-scale recording**
  Any portion within full scale can be expanded or reduced for each pen
- **AUTO span shift**
  On AUTO SPAN SHIFT mode, recording span is automatically shifted to ±50%, and recording continues when the input exceeds the measuring span.
- **GPIB or RS-232-C interface (Optional)**
  An optional feature of either GPIB or RS-232-C can handle data output and panel setting data. Analog recording of digital inputs is also available through the computer interface
- **Easy-to-operate design**
  Operation is very simple like as conventional analog recorders.
- **Standard or optional memory card**
  Standard memory card is used for storing panel setting data, while optional memory card, for storing measured and panel setting data with memory capacity of 256K bytes.

The LR4200 Series is a family of YOKOGAWA LR8100 and LR4100 Series recorders, and available as 1- to 4-pen flatbed type lineup.

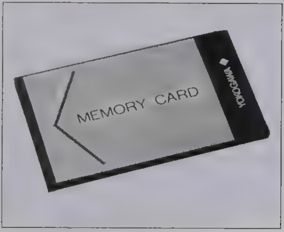
LR4200 Series provides multifunction and excellent price/performance advantage like as conventional analog recorders.

Furthermore, LR4200 Series includes versatile many standard and optional features such as analog recording/digital printout, memory card, and communication functions.

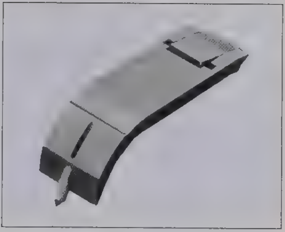
# LR 4220

## (Without printer, with manual pen lift)

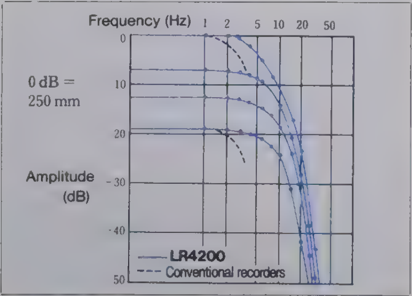
- **New recording mechanism for long-term clear, distinct color traces**
  New recording system features total pen trace length of about 1,500 m (4,900 ft) without smudge.
- **High pen speed — 1,600 mm/s max.**
- **Wide voltage range power supply of 90 V to 250 V AC**
- **A wide range of optional features — Mathematical functions, remote controls, alarms and °F display**
- **Mathematical functions**
  Difference computation between channels and scaling for each channel is available as a standard. +, −, ×, ÷, square root, absolute value, logarithm and exponential function are available as an option.
- **Remote controls**
  Chart start/stop, chart speed, chart speed change, RECORD ON/OFF selection, message, manual printout (LR4210) and pen lift can be controlled with remote control signal.
- **Alarm outputs of up to 4 points**
  Alarm setting of up to 4 levels/channel of high and low alarms



▲ Memory card



▲ Disposal felt-tip pen cartridge



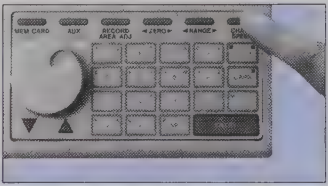
▲Frequency characteristics

# Simplified Programming Like Conventional Recorders.

**LR4200** features simple menu setting with interactive display.
Following three steps are the examples of chart speed setting:

### *STEP 1*

**CHART SPEED key (function key)**
Depress to display the chart speed.



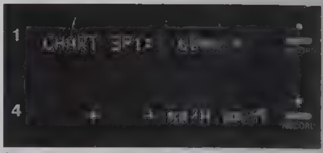
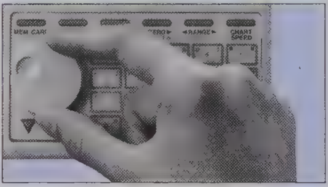


Chart speed setting display

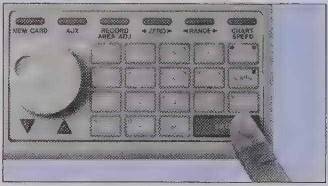
### *STEP 2*

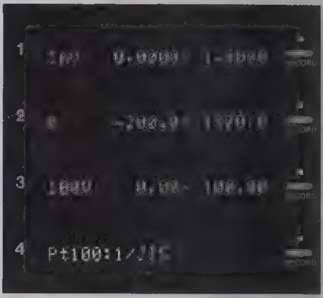
**Menu setting knob**
By rotating this knob, 17 chart speeds (in mm or inch) are alternately displayed. Other chart speeds can also be programmed in 1 mm or 0.1 inch steps via alphanumeric key operations.



### *STEP 3*

**ENTRY key**
Depress ENTRY key (end of setting).



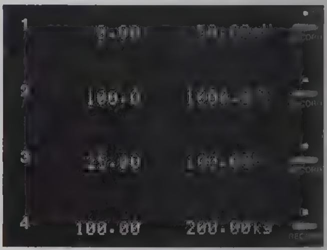


Range setting display

- **Veresatile Display Modes**

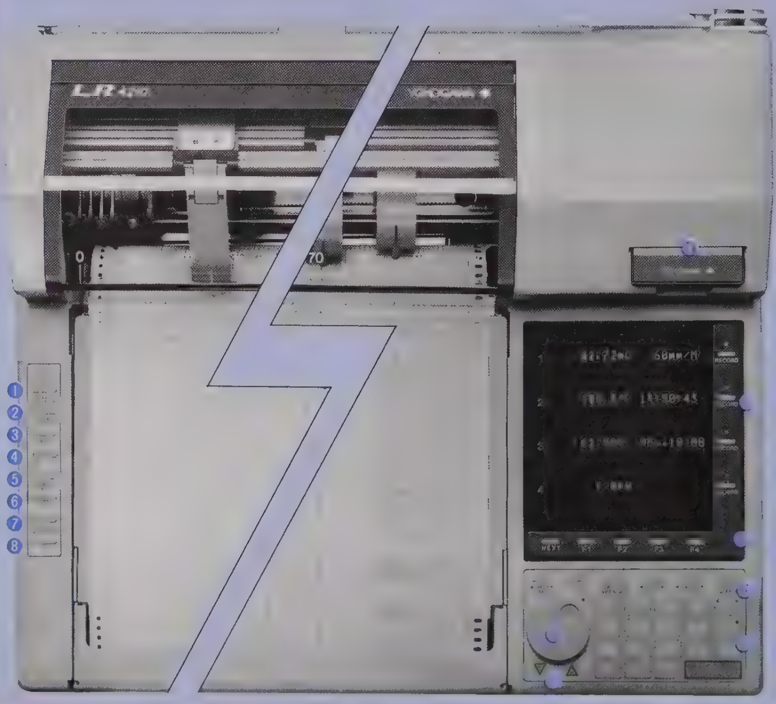
Measured data display

Bar graph display



Range data display

## Panel Layout & Functions (LR4210)



① **DISPLAY SELECT:** Selects the display (measured data, bar graph or range)
② **CHART :** Starts the chart drive
③ **FEED:** Feeds the chart at a touch of this key
④ **PEN LIFT:** Lifts or lowers all the pens simultaneously
⑤ **MANUAL PRINT:** Prints out measured data in a single line
⑥ **LIST:** Used for program list printout
⑦ **MANUAL MESSAGE:** Starts to print the message of up to 70 characters.
⑧ **POC:** Pen offset compensation ON/OFF key
⑨ **Memory card slot**
⑩ **RECORD:** Recording ON/OFF keys for each channe.
⑪ **Function keys**
**NEXT:** Selects to the next menu on display
**F1 to F4:** Function keys for meun setting
⑫ **Function keys**
**MEMORY CARD (Local):** For setting the memory card and GPIB local with SHIFT key
**AUX (keylock):** For setting alarms, tag number message and clock, and key lock from ⑪ to ⑮ keys with SHIFT key
**RECORD AREA ADJ:** For setting recording span for each channel
**ZERO SPAN:** Used for zero adjustment or change of recording span
**RANGE:** For setting measuring range
**CHART SPEED:** For setting chart speed
⑬ **Menu setting knob:** Displays menu setting of range and chart speed
⑭ **Cursor keys:** Shift the cursor on screen up and down
⑮ **Alphanumeric keys:** 18-key setting key pads
**ENTRY:** Depress to make entry setting

# Specifications

## MEASUREMENTS

**Drive System:** Automatic null-balancing digital servo mechanism with brushless DC servomotor.

**Type of Input:** Floating, guarded and shielded (No guard on 10 mV F.S. model).

**Input Types & Measuring Ranges:** DC V... 10 mV to 200V F.S., 1 mV to 200 V F.S., or 0.1 mV to 200 V F.S.

TC (ANSI, DIN, JIS)...Type R, S, B, K, E, J, T, N, W, L (DIN), U (DIN).

TC (NBS)...KP vs Au7Fe (4 to 280K).

RTD (DIN, JIS or SAMA)...Pt100 (1 mA), Pt50 (1 mA), Ni100.

RTD...Pt100 (1 mA), JPt100 (1 mA), Pt50 (1 mA), Ni100 (1 mA), J263*B, Pt100: JIS C1604-1989, JIS C1606-1989, DIN IEC 751, IEC 751, JPt100: JIS C1604-1989, JIS C1606-1989 : Pt50 : (JIS C1604-1981, JIS C1606-1986), Ni100 : DIN, SAMA.

**Accuracy:** DC V... ± (0.05% of rdg + 0.03% of range + 0.5 μV).

TC... ±(0.05% of rdg + 0.5°C) for K, E, J, T, L, U and KP vs Au7Fe, ±(0.05% of rdg + 1°C) for R, S and B, ±(0.1% of rdg + 0.5°C) for N, ±(0.1% of rdg + 1°C) for W.

RTD... ±(0.05% of rdg + 0.2°C) for Pt100 and Ni100, ±(0.05% of rdg + 0.3°C) for Pt50 and J263*B. (at 23 ±2°C, 55±10% R.H.).

**Reference Junction Compensating Accuracy (TC):** ±0.5°C for K, E, J, T, N, W, L, U and KP vs Au7Fe, ±1°C for R, S and B (measuring range of down to −100°C).

**Bias Current:** 4 nA.

**Filter:** 0.1, 1 Hz or OFF (selectable).

**Zero Set:** Adjustable.

**Measuring Cycle:** 135 Hz.

**Pen Offset Compensation (Standard):** Average, max./min. recording selectable (with compensation ON/OFF switch), resolution on time axis... 0.05 mm, automatic sweep function for pen offset data selectable POC (Pen Offset Compensation) reference pen.

**Input Impedance:** Approx. 1 MΩ (DC V & TC).

**Allowable Source Resistance:** Less than 1 kΩ (DC V & TC).

**Temperature Coefficient:** Zero drift...0.05μV/°C + 0.01% of range/°C, F.S. ...0.01% of range/°C.

**Maximum Allowable Input Voltage:** 250 V DC.

**Maximum Common Mode Voltage:** 250 Vrms AC.

**Commom Mode Rejection:** More than 150 dB at AC.

**Normal Mode Rejection:** More than 50 dB at 50 or 60 Hz.

## RECORDING & PRINTING

**Writing System:** Ink writing using disposable felt-tip pen cartridges (analog data).

**Printing System*:** Wire-dot printer using ribbon cassette (digital data).

**Effective Recording Span:** 250 mm (analog data).

**Pen Offset between Channels:** Approx. 4 mm on the time axis.

**Number of Channels:** 1, 2, 3 or 4.

**Recording Colors:** 1st pen...red, 2nd pen...green, 3rd pen...blue, 4th pen...brown.

**Recording Accuracy:** Measurement accuracy + ±0.2% of effective recording span (including non-linearity, dead-band and error between ranges).

**Maximum Pen Speed:** Approx. 1,600 mm/s.

**Maximum Pen Acceleration:** Approx. 8G.

**Printing Rate*:** Approx. 1.5 s/line.

**Chart:** Z-fold chart (270 mm × 20 m), Roll chart (270 mm × 20 m)...optional.

**Chart Speeds:** 10 to 1,200 mm/min & mm/h (1 mm steps), and 0.5 to 45.0 inch/min & inch/h (0.1 inch steps).

**Change of Chart Speed:** Changes chart speed with remote control signals (optional).

**RECORD ON/OFF Selectors:** Independently provided for each channel on the front panel (ON...measurement/recording, OFF...measurement).

**Pen Lift*:** All pens are simultaneously lifted and lowered.

**Chart Drive:** Pulse motor drive.

**Chart Speed Accuracy:** ±0.1% (at recording of longer than 1 m).

**Digital Data Printout*:** Time, chart speed, channel number (tag number), measured data and engineering unit are printed out at the following intervals:

| Chart speed | | Printing intervals |
|---|---|---|
| mm/min | mm/h | |
| 1,200 to 300 | — | 1 min |
| 299 to 30 | — | 10 min |
| 29 to 10 | 1,200 to 120 | 1 h |
| — | 199 to 60 | 2 h |
| — | 59 to 40 | 3 h |
| — | 39 to 20 | 6 h |
| — | 19 to 10 | 12 h |

**Tag Number Printout*:** Tag number can be printed out in place of channel number (up to 7 alphanumerics).

**Alarm Printout*:** Channel number, alarm type, and the time of alarm ON/OFF are printed.

**Scale Markings Printout*:** 0% and 100% scale values can be printed out at the same interval as digital printout.

**Program List Printout*:** Contents of entire setting memory can be listed on the chart.

**Manual Printout*:** Time and measured data for all channels can be printed out in a single line by a push of MANUAL PRINT key.

**Message Printout*:** Message of up to 70 characters can be printed at a push of MANUAL MESSAGE key (Message 0), or by external contact signal (Message 1 to 4; optional, up to 4 channels).

**Change of Chart Speed Printout*:** Chart speed and time can be printed out at the change of chart speed.

**Pen Offset Compensation ON/OFF Printout*:** ON, OFF mark and time can be printed out.

**Change of Range Printout*:** Changed contents and time can be printed at the change of range (on Auto span shift mode).

**Partially Expanded-Scale Recording:** Any portion within full scale can be expanded or reduced for each channel.

**Auto Span Shift Mode:** Automatically shifts to ±50% of span, and recording continues when the input exceeds the measuring span.

**External Input Span:** Small error of external converter can be corrected by setting the span with actual input voltage (zero...span left, full...span right).

*Note: **LR4210** only

## DISPLAY

**Type of Display:** Vacuum fluorescent display (5 × 7 dot matrix, blue), 20 characters for each channel.

**Display Modes:** 3 display modes can be selected at a push of DISPLAY SELECT key; Digital data display...Measured data (7 digits), date and time, and chart speed, Bar graph display (2.5% resolution), Range data display.

## ALARMS

**Number of Alarm Set Levels:** Up to 2 levels/channel.

**Alarm Types:** High (H), low(L), delta high (dH), and delta low (dL).

**Alarm Outputs (Optional):** Up to 4 points (internal, contact rating...24 V DC and AC 1A).

## COMPUTING FUNCTIONS

**Standard Functions:** Scaling (ranges... −22000 to +22000), and ΔT.

*__Optional Mathematical Functions:__ +, −, ×, ÷, square root, absolute value, logarithm, exponential function (up to 4 channels).

*Not available for 1-pen model.

## GENERAL SPECIFICATIONS

**Standard Memory Card:** For storing the setting data (memory capacity of 8K bytes), standard accessory... lithium battery, 1 pc. (battery life of about 5 years).

**Battery-Backup Memory:** Maintains all setting for about 10 years (at room temperature) when power is removed.

**Chart END Alarm:** Automatic pen lift (**LR4210** only) at out-of-chart condition (alarm output, optional).

**Mounting:** Horizontal (may be inclined up to 10° from horizontal)

**Operating Temperature Range:** 0 to 40°C (32 to 104°F).

**Humidity Range:** 30 to 80% relative humidity.

**Insulation Resistance:** More than 100 MΩ at 500 V DC between power line and case, and between input terminals and case.

**Dielectric Strength:** 1,500 V AC for one minute between power line and case, and between input terminals and case.

**Power Requirements:** 90 to 250 V AC, for both 50 and 60 Hz.

**Power Consumption:** 1 channel model... 85 VA max., 45 VA balanced, 2 channel model...100 VA max., 50 VA balanced, 3 channel model... 115 VA max., 55 VA balanced, 4 channel model... 130 VA max., 60 VA balanced.

**Dimensions:** Approx. 185(H) × 448(W) × 455(D)mm, (7 - 1/4 × 17 - 5/8 × 17 - 7/8").

**Weight (Approx.):**

| Model | 1-channel | 2-channel | 3-channel | 4-channel |
|---|---|---|---|---|
| LR4210 | 12.5kg(27.6lbs) | 13kg(28.7lbs) | 13.5kg(29.8lbs) | 14kg(30.9lbs) |
| LR4220 | 11.5kg(25.4lbs) | 12kg(26.5lbs) | 12.5kg(27.6lbs) | 13kg(28.7lbs) |

## OPTIONAL FEATURES

### ■ GPIB INTERFACE (/GP-IB)

**Functional, Electrical and Mechanical Specifications:** Meets the IEEE Standard 488-1978.

**Talker Functions:** Input of measured data (ASCII), output of measured data (ASCII and binary), input/output of setting data (ASCII), output of memory data (ASCII and binary).

**Listener Functions:** Controls except for power ON/OFF key lock ON/OFF and chart drive.

### ■ RS-232-C INTERFACE (/RS232C)

**Functional, Electrical and Mechanical Specifications:** Meets the EIA RS-232-C.

**Controller Interface Functions:** Input of measured data (ASCII), output of measured data (ASCII and binary), input/output of setting data (ASCII), output of memory data (ASCII and binary).

**Data Transfer Rates:** 75, 150, 300, 600, 1,200, 2,400, 4,800, 9,600 bps.

### ■ REMOTE CONTROLS (/REM)

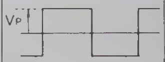
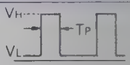
**Remote Control Signals:** External contact, open collector or TTL-level signal.

**Chart Drive Control:** Start...L logic level or closed contact, Stop... H logic level or open contact.

**Change of Chart Speed:** Chart speed 2... L logic level or closed contact, Chart speed 1... H logic level or open contact.

**Manual Printout*:** Printout date & time and measured data ... L logic level or closed contact.

**Chart Speed:**

| Remote control signal waveforms | Sine, triangular rectangular waves | Pulse train |
|---|---|---|
| Signal level |  $4V < V_P < 24V$ |  $+4V < V_H < +24V$<br>$-24V < V_L < +0.5V$<br>$T_P > 300\mu s$ |
| Max. signal source impedance | 600 Ω | 50 Ω |
| Chart speed | 0.15f cm/min (f... Hz or PPS) | |
| Max. frequency | 800 Hz | 800 PPS |

**Message Printout*:** Start... L logic level or closed contact.

**Pen Lift*:** All recording pens lowered... L logic level or closed contact, all recording pens lifted... H logic level or open contact.

**RECORD ON/OFF Selection:** OFF (measurement)... L logic level or closed contact, OFF (measurement/recording)... H logic level or open contact.

**External Trigger:** Data memory (**378904**), write... L logic level or closed contact.

*Note: **LR4210** only.

### ■ ALARMS (/AK-04)

**Number of Outputs:** 4 points (internal).

**Contact Rating:** 24 V DC and AC 1A.

**Outputs:** Alarm, FAIL alarm and chart END alarm outputs

### ■ ROLL CHART DRIVE (/ROL)

Both Z-fold and roll chart can be used. (Roll chart must be ordered).

### ■ CHART REROLL (/REROL)

Remote control of roll chart drive by external signal. (contact, open collector or TTL-level signal), or by depressing front-panel keys. (Roll chart... optional).

## OPTIONAL ACCESSORY

### MEMORY CARD (378904)

**Function:** Setting & measured data memory.

**Data Format:** MS-DOS.

**Sampling Rate:** Free mode (manual start)...135, 9, 5, 3, 1, 0.5, 0.2 Hz, trigger mode (starts by trigger conditions)... 9, 5, 3, 1, 0.5, 0.2 Hz.

**Memory Capacity:** 256K bytes.

**Data Length:** 1,000, 2,000, 4,000, 8,000, 16,000, 32,000 data/channel (common setting to each channel, 2 bytes/data).

**Trigger Condition:** Alarm detection, CHART END or external contact input (optional).

**Pre-Triger:** 0 to 100% (10% steps).

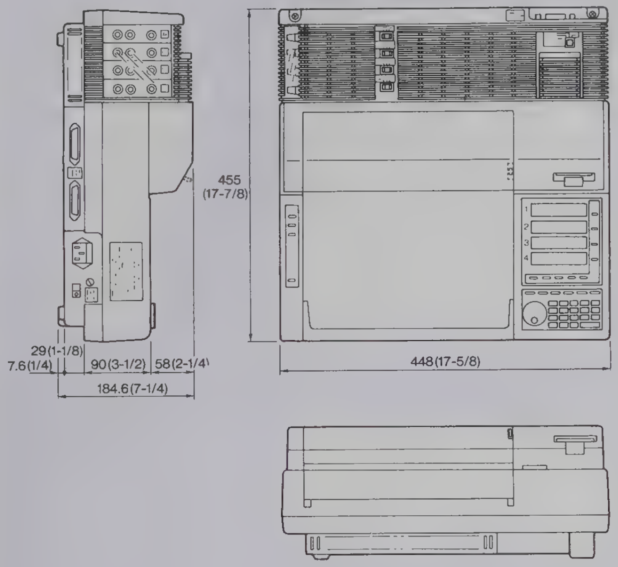
**Memory Data:** Measured data, interface input data and computed data.

**Output:** Communication interface and recording output.

**Standard Accessory:** Lithium battery... 1 pc. (battery life of about 3 years).

## Dimensions

Unit: mm (approx. inch)



Note: Dotted line...Manual pen lift (**LR4220**)

## Model and Suffix Codes

| Model | Suffix Codes | Description |
|---|---|---|
| 3721 | ............ | LR4210 Recorder<br>(with printer & electrical pen lift) |
| 3722 | ............ | LR4220 Recorder<br>(without printer, with manual pen lift) |
| No. of channels | 1 ............ | 1-channel model |
| | 2 ............ | 2-channel model |
| | 3 ............ | 3-channel model |
| | 4 ............ | 4-channel model |
| Input types & max. sensitivity | 1 ............ | 10 mV F.S. (DC V,TC) |
| | 2 ............ | 1 mV F.S. (DC V,TC) |
| | 3 ............ | 0.1 mV F.S. (DC V,TC) |
| | 4 ............ | 10 mV F.S. (DC V,TC,RTD) |
| | 5 ............ | 1 mV F.S. (DC V,TC,RTD) |
| | 6 ............ | 0.1 mV F.S. (DC V,TC,RTD) |
| Version up | -B ............ | |
| Power requirement | -O ............ | 90 to 250 V AC |
| Optional features | GP-IB | GPIB interface |
| | /RS232C | RS-232-C interface |
| | MATH | Mathematical functions |
| | /AK-04 | Alarms (internal 4 points) |
| | /REM | Remote controls |
| | ROL | Roll chart drive |
| | REROL | Chart reroll |
| | DF | °F display |

## Accessories & Spares

| Name | | Standard Accessories | Spares | |
|---|---|---|---|---|
| | | | Part No. | Order Q'ty |
| Ribbon cassette (for **LR4210**) | | 1 pc. | **B9585SH** | 1 unit (1 pc./unit) |
| Z-fold chart (270mm x 20m) | | 1 chart | **B9619AH** | 10 units (1 pc./unit) |
| Roll chart (270mm x 20m) | | – | **B9622AH** | |
| * Disposal felt-tip pen cartridge | 1st channel (red) | – | **B9586☐A** | 1 unit (3 pcs./unit) |
| | 2nd channel (green) | – | **B9586☐B** | |
| | 3rd channel (blue) | – | **B9586☐C** | |
| | 4th channel (brown) | – | **B9586☐D** | |
| | 1st to 4th channels | 1 pc. each | **B9586☐R** | 1 unit (1 pc. each/unit) |
| Memory card (setting data) | | 1 pc. | **378901** | 1 unit (1 pc./unit) |
| Memory card (setting data & measured data) | | – | **378904** | |
| Lithium battery (for mainframe) | | 1 pc. | **B9588ZB** | |
| Lithium battery (for **378901**) | | 1 pc. | **B9586JU** | 2 units (1 pc./unit) |
| Lithium battery (for **378904**) | | – | **B9586JV** | |
| Dust cover | | – | **B9622AV** | 1 pc. |
| Measurement leads (1m) | | – | **B9409JA** | 1 set |
| Power cord | | 1 set | Order by name | |
| Fuse | | 1 pc. | Order by name | |

* Note: Specify one of code (**X**,**Y** or **Z**) in ☐

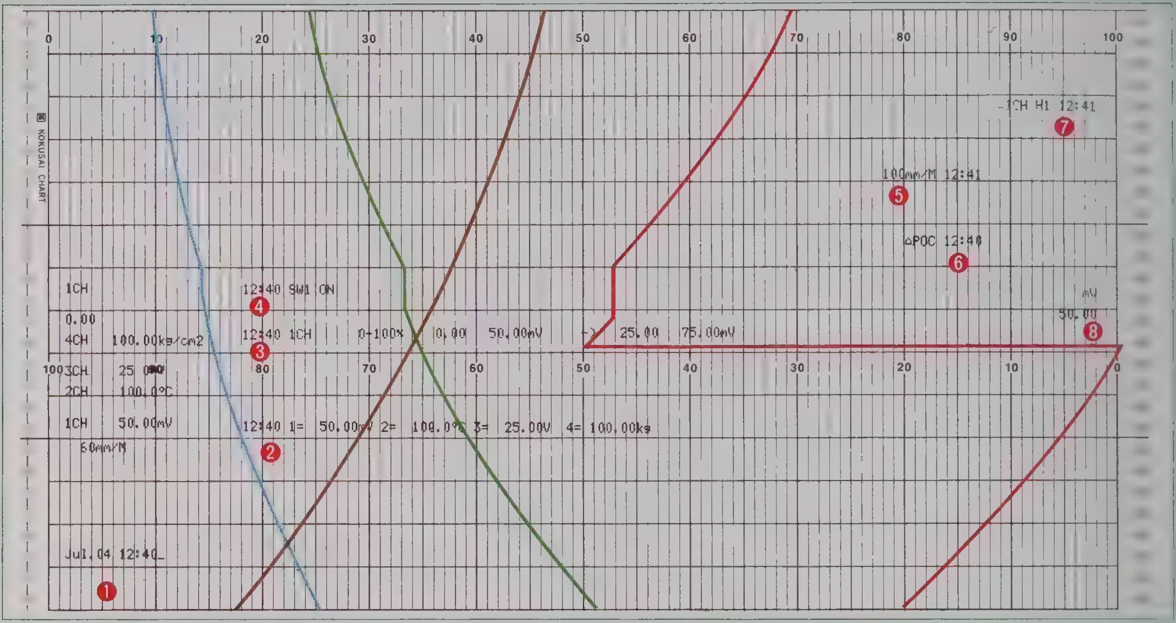
**Y**...Standard (pen speed of lower than approx. 800mm/s)

**Z**...High speed (pen speed of higher than approx. 800mm/s)

**X**...Low speed (chart speed of lower than approx. 100mm/h)

# Maximum Flexibility in Analog Recording/ Digital Printout.

An Example of Recording/Printout (LR4210)



① **Digital Data Printout:** Digital data are printed out at regular time intervals (1 minute min.) corresponding to chart speed.

② **Manual Printout:** When MANUAL PRINT key is depressed, digital data of time and measured data for all channels are printed out in a single line.

③ **Change of Range Printout:** When range is changed, time, old and new ranges are printed out.

④ **Message Printout:** The time and message (up to 70 characters) can be printed by depressing MANUAL MESSAGE key, or by external contact signal.

⑤ **Change of Chart Speed Printout:** When chart speed is changed, new chart speed and time can be printed.

⑥ **Pen Offset Compensation ON/OFF Printout:** ON (△POC) or OFF (▽POC) and time are printed out.

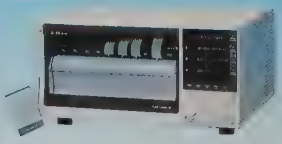
⑦ **Alarm Printout:** Channel number, alarm type and time of alarm ON/OFF are printed.

⑧ **Scale Markings:** Scale values of 0% and 100% are printed at regular intervals corresponding to chart speed.

**LR Series Recorder Family**

(4-,6-,8-channel models)

(1-,2-,3-,4-channel models)



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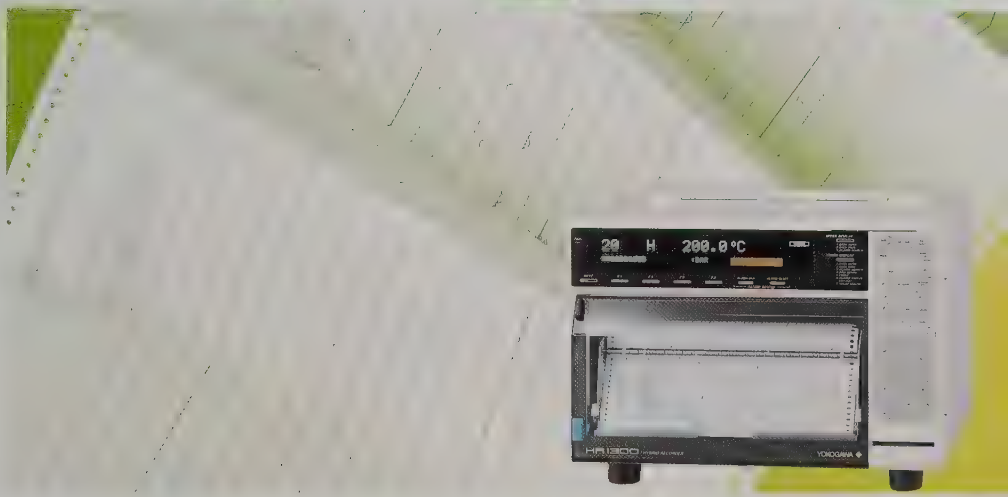
YOKOGAWA

High-speed scanning of 20 points/2 s
High-speed recording of 50 points/2 s

# HR



# PORTABLE HYBRID RECORDER HR1300

Bulletin 3750-E

# Easy-to-Carry, Lightweight Design.

## Portable Hybrid Recorder with Upgraded Recording and Analysis Functions.

The YOKOGAWA HR1300 is a high-speed portable hybrid recorder with upgraded functions and performance. It uses a high breakdown voltage solid state relay, which offers high-speed scanning and recording. It is user-friendly and ideal for many fields of applications.

### Multifunction in a Portable Package.

- Small and lightweight (approx. 9.7kg) design with both AC & DC power operation.

### High-Speed Scanning of 20 Points/2 s

- Provided with a YOKOGAWA-developed high breakdown voltage solid state relay.

### High-Speed Recording of 50 Points/2 s

- 30 points for computation and other features are available in addition to 20-input points.

### Programmable Ten-Color Recorder

- Recording colors can be assigned to designated channel.

### Powerful Computing Functions (Optional)

- +, −, ×, ÷, statistical, logical and relational computation.

### Memory Card of up to 512K bytes

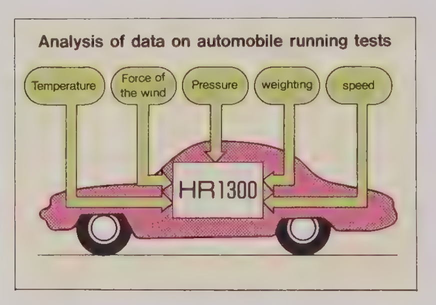
- Saving and loading of settings, measured and computed data.

# High-Speed Scanning and Maximum Relay Life.

## Through the Use of YOKOGAWA-Original Solid State Relay.

### 1. Versatile Functions within a Portable Package

The HR1300 incorporates many outstanding functions, weighs less than 10 kg, and can be DC powered. So, this allows the recorder to be used in many fields of applications.



### 2. High-Speed Scanning: 20 Points/ 2 seconds

Detailed analysis is possible because digital data which is scanned every 2 seconds, and transferred to memory card or to a supervisory computer via a GPIB or RS-232-C interface.

- **YOKOGAWA-original high breakdown voltage solid state relay.**
- Higher scanning speed than electromagnetic relay.
- Long life relay.
- No relay noise.

YOKOGAWA-original high breakdown voltage solid state relay.

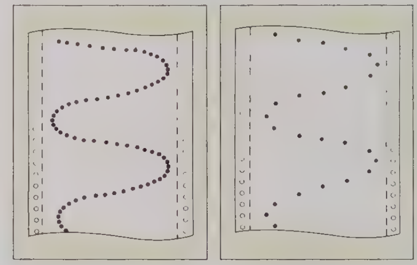
### 3. Ten-Color Recording

Each channel is recorded in one of ten distinct colors: black, blue, navy blue (new), green, yellowish green (new), purplish red (new), brown, orange (new), red and purple.

Color can easily be designated for each channel, so the important measurement data can be assigned for selected colors. Zone recording, partially expanded-scale printout, message printout, Tag No., header printout (60 characters×5 lines) are also available.

### 4. High-Speed Recording: 50 Points/ 2 Seconds

In two seconds, 20 input points in addition to another 30 points for computed data, digital inputs and memory card data can be recorded in analog form. High-speed recording of varions inputs, in several recording formats, makes detailed data analysis of even extremely fast phenomenon easier than ever before.



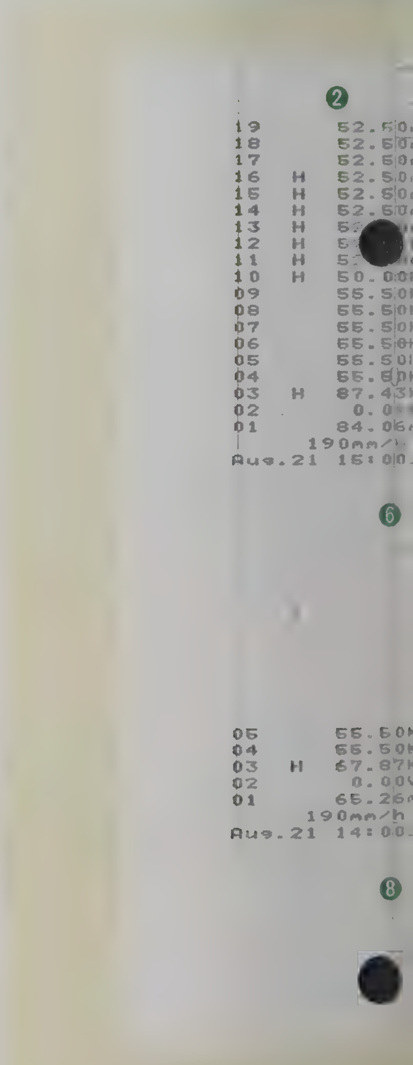
● HR1300 ● Current model

### 5. IC Memory Card

- Large memory capacity of 512K bytes.
- Up to 47 files of both setting and measured data can be stored.
- Data is composed of two bytes (max. 32,000 data/channel).
- Data saving to the memory card can be started by:
  - ①The front panel
  - ②Alarm occurrence
  - ③Contact inputs to the rear
  - ④Chart END
- Data prior to an alarm occurrence can also be collected using the pre-trigger function.

Ten color ribbon

## Complete Information

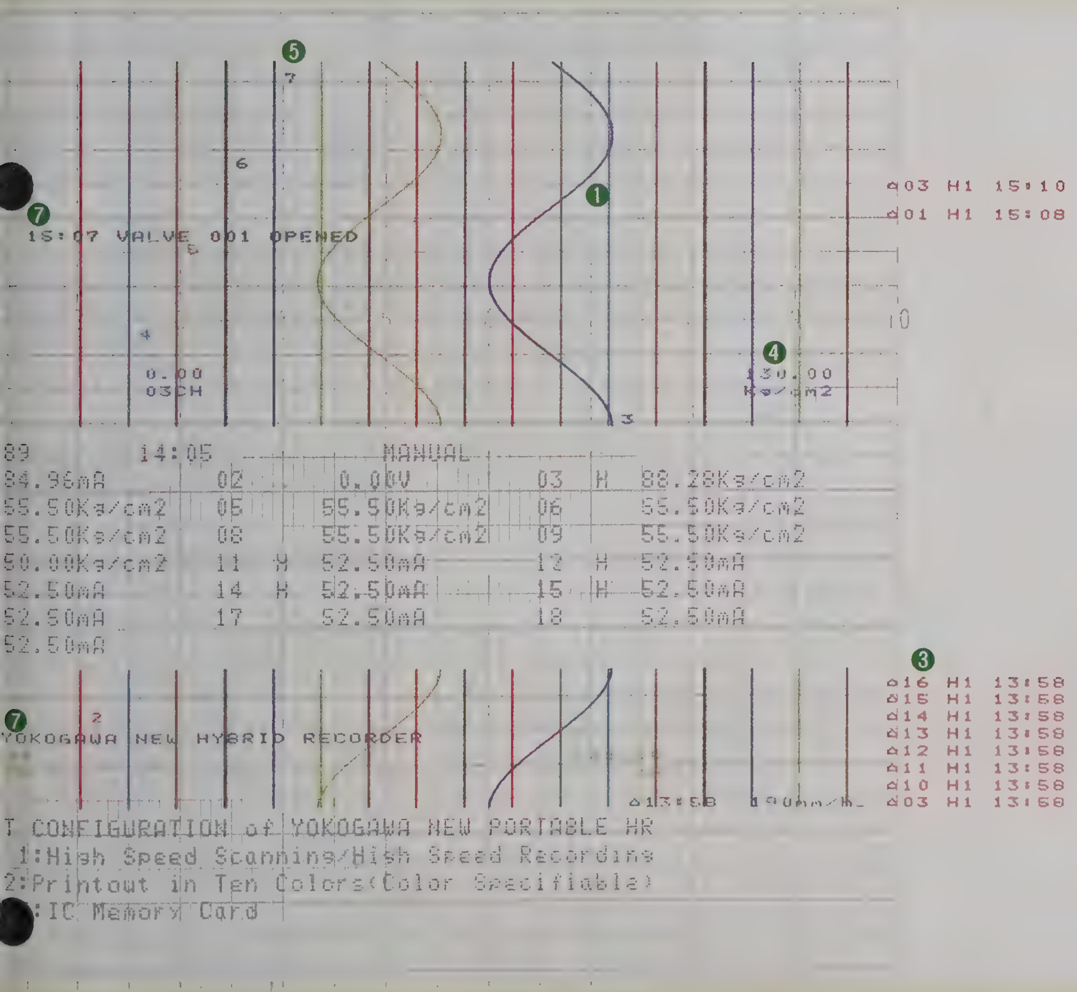


❶ Analog data ❷ Digital printout ❸ A

## Versatile Convenient Features with 150mm Calibrated Chart

- **Powerful Computing Functions (Optional)**
- **Computer Friendly (Optional)**
  Bidirectional communications via GPIB or RS-232-C interface.
- **Universal Input Types**
  DC Voltages: 20mV to 50V DC, TC: 12 types, RTD: 14 types, contact status for event recording.
- **High Accuracy: ±(0.05% of rdg + 2 digits on 2V range)**
- **ΔT Measurement, Scaling Function**
- **Highly Visible Vacuum Fluorescent Display (7×5 dots)**
- **Wide Voltage Range of Power Supply ....90 to 250V AC**
- **Versatile Optional Features and Accessories:**
  GPIB, RS-232-C interface, remote control, IC memory card, AC input (voltage and current), user's linearization, remote RJC, mathematical functions, internal alarm output relay, DC V power source (10 to 32V DC).

## Distinct Ten Colors. Any Color can be Assigned for Each Channel



```
89          14:05             MANUAL
84.96mA      02         0.00V          03  H   88.28Kg/cm2
55.50Kg/cm2  05         55.50Kg/cm2    06      55.50Kg/cm2
55.50Kg/cm2  08         55.50Kg/cm2    09      55.50Kg/cm2
50.00Kg/cm2  11  H      52.50mA        12  H   52.50mA
52.50mA      14  H      52.50mA        15  H   52.50mA
52.50mA      17         52.50mA        18      52.50mA
52.50mA
```

```
YOKOGAWA NEW HYBRID RECORDER
```

```
△16 H1 13:58
△15 H1 13:58
△14 H1 13:58
△13 H1 13:58
△12 H1 13:58
△11 H1 13:58
△10 H1 13:58
△03 H1 13:58
```

```
T CONFIGURATION of YOKOGAWA NEW PORTABLE HR
 1:High Speed Scanning/High Speed Recording
2:Printout in Ten Colors(Color Specifiable)
 :IC Memory Card
```

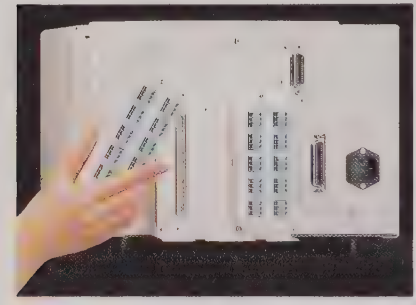
ut ④ Scale values printout ⑤ Tag No. (or channel No.) printout ⑥ Manual printout ⑦ Message printout ⑧ Header printout

# Easy-to-Operate Design.

## Interactive Menu-Driven Setting with Large VFD Display.

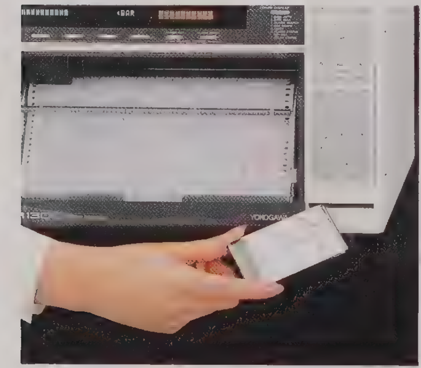
### Input Terminal Block

The input terminal block can be removed from the recorder for easier wiring. Even the many connections needed for multi-point recording can be performed quickly and conveniently.



### Easy Data Setting by Using an IC Memory Card

Having programmed the setting data using the interactive menus, all parameters can be stored on an IC memory card. Later, these settings can be quickly retrieved and modified or used as it.

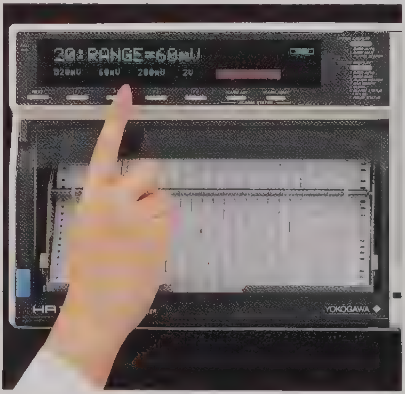


### Easy Chart Replacement

A detachable chart cassette makes chart replacement convenient and easy. For example, chart can be loaded without smudge.

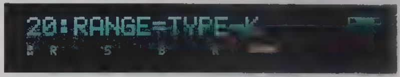
### Easy Key Operations

Interactive menu-driven display with guide indicators allow easy key operation without consulting instruction manual.

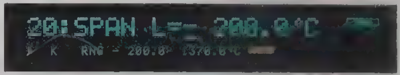


### Setting Display

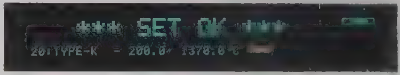
Interactive setting: Function key labels appear on the display.



The display shows the setting range.



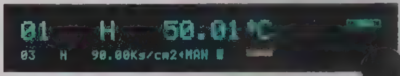
The display shows the setting contents at the end of programming.



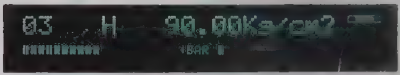
### Measurement Display

A variety display modes are selectable.

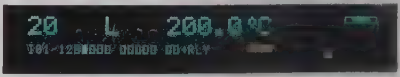
Both UPPER and LOWER DISPLAY shows the measurement data in digital



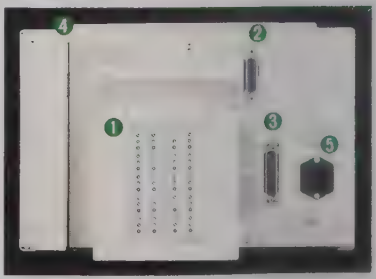
The UPPER DISPLAY shows [illegible] measurement data in digital, and LOWER DISPLAY, a bargraph.



The UPPER DISPLAY shows the measurement data in digital, and the LOWER DISPLAY, the relay output.



### Rear Panel



① Input terminal block
② GPIB or RS-232-C interface termina[illegible]
③ Remote terminal/alarm output relay (/AK-02)/FAIL/chart end terminal
④ DIP switch
⑤ Power connector

# SPECIFICATIONS

## MEASUREMENTS

● **Number of Inputs**: Up to 10 or 20 points.

● **Input Types, Ranges, Accuracy and Resolution:** At 23±2°C and 55±10% R.H.

* Any of DC V, TC, RTD, and DI inputs can be selected for each input point.

| Input Type | Range | Measurement (Digital display & printout) | |
|---|---|---|---|
| | | Accuracy | Resolution |
| DC V | 20mV | ±(0.05% of rdg+5 digits) | 1μV |
| | 60mV | ±(0.05% of rdg+2 digits) | 10μV |
| | 200mV | ±(0.05% of rdg+2 digits) | 10μV |
| | 2V | ±(0.05% of rdg+2 digits) | 100μV |
| | 6V | ±(0.05% of rdg+2 digits) | 1mV |
| | 20V | ±(0.05% of rdg+2 digits) | 1mV |
| | 50V | ±(0.05% of rdg+2 digits) | 10mV |
| TC | *1 R<br>*1 S | ±(0.05% of rdg+1°C)<br>R, S: 0 to 100°C ±3.7°C<br>100 to 300°C±1.5°C<br>B: 400 to 600°C±2°C | 0.1°C |
| | *1 B | | |
| | *1 K | ±(0.05% of rdg+0.7°C)<br>−200 to −100°C<br>±(0.05% of rdg+1°C) | 0.1°C |
| | *1 E<br>*1 J<br>*1 T | ±(0.05% of rdg+0.5°C)<br>J, L: −200 to −100°C<br>±(0.05% of rdg+0.7°C) | |
| | *2 L<br>*2 U | | |
| | *3 N | ±(0.1% of rdg+0.7°C) | 0.1°C |
| | *4 W | ±(0.1% of rdg+1°C) | |
| | *5 KP vs Au7Fe | ±(0.05% of rdg+0.7K) | 0.1K |
| RTD | *6 Pt100 (1mA, 2mA)<br>*6 JPt100 (1mA, 2mA) | ±(0.05% of rdg+0.3°C) | 0.1°C |
| | *7 Pt50 (2mA) | ±(0.05% of rdg+0.3°C) | |
| | *8 Ni 100 (1mA)<br>*8 Ni 120 (1mA) | ±(0.05% of rdg+0.3°C) | 0.1°C |
| | *9 J263*B | ±(0.05% of rdg+0.3K) | 0.1K |
| | Cu10<br>GE, L&N, WEED, BAILEY | ±(0.2% of rdg+0.7°C) | 0.1°C |
| | High-sensitivity model<br>Pt 100 (1mA)<br>Pt 100 (2mA)<br>JPt100 (1mA)<br>JPt100 (2mA) | ±(0.05% of rdg+0.3°C) | 0.01°C |
| Contact Status (input signal: contact status or DC V) | | | |

*1 R, S, B, K, E, J, T: ANSI, IEC 584, DIN IEC 584 JIS C 1602-1981

*2 L: Fe-CuNi, DIN 43710
U: Cu-CuNi, DIN 43710

*3 N: Nicrosil-Nisil
IEC 584, DIN IEC 584

*4 W: W・5%Re-W・26%Re
Hoskins Mfg Co

*5 KP vs Au7Fe: NBS Vol. 76A

*6 Pt100: JIS C 1604-1989, JIS C 1606-1989
IEC 751, DIN IEC 751
JPt100: JIS C 1604-1989, JIS C 1606-1989

*7 Pt50: JIS C 1604-1981, JIS C 1606-1984

*8 Ni100: SAMA, DIN 43760
Ni120: McGRAW EDISON

*9 J263*B (Pt-Co): YOKOGAWA

● **Recording Resolution (Analog trend)**: 0.04% of span.

● **Reference Junction Compensation Error**: [illegible] (R, S, B, W), ±0.5°C (K, J, E, T, N,. [illegible], KP vs Au7Fe)

● **Scan Cycle Time**: 2 to 60s selectable (2, 3, 4, 5, 6, 10, 12, 15, 20, 30, 60s).

● **Scanning Rate**: 60ms/channel.

● **A-D Integration Time**: 20ms (50Hz), 16.7 ms (60Hz), and 100ms (50/60Hz) are selectable via an internal DIP switch.

● **Input Impedance**: More than 10MΩ on 2V or lower ranges and TC, Approx. 1MΩ on 6V or higher ranges.

● **Input Bias Current**: Less than 10nA.

● **TC Burnout Protection**: 2kΩ or less (normal), 100kΩ or more (open), current approx. 6μA, detection pulse width approx. 2ms, (ON or OFF selectable for each channel).

● **Temperature Coefficient**: Zero drift; 0.01 % of range/°C, Full span; 0.01% of range/°C.

● **Maximum Allowable Input Voltage**: 60V DC.

● **Maximum Common Mode Voltage**: 250 Vrms AC.

● **Common Mode Rejection**: More than 120 dB (50 or 60Hz±0.1%).

● **Normal Mode Rejection**: More than 40 dB (50 or 60Hz±0.1%).

## PRINTOUT

● **Printing Technique**: Raster scan using a wire-dot printer and a 10-color ribbon.

● **Effective Recording Span**: 150mm (5-7/8") (analog data).

● **Chart**: Z-fold chart (230mm×20m, 9"×65-1/2') with calibrated width of 150mm.

● **Recording Colors**: Analog data (TREND mode)…10 colors (black, blue, navy blue, green, yellowisch green, purplish red, brown, orange, red and purple), Color can be specified for every channel. Digital data (TREND mode) … channel number, measured data, date & time, chart speed (black), alarm (ON mark; red, OFF mark; blue), (LOG & LIST modes) … all data (purple).

● **Recording Accuracy**: Measurement accuracy +(±0.2% of effective recording span).

● **Printout Format**: Analog trend/analog trend+digital/logging.

In the trend mode…the following recording is available.

Zone recording, partially expanded-scale printout assignable for every points.

In the trend mode, recording can also be turned ON/OFF in every channel for the following items (panel setting), Analog recording, measured value printing (1 to 4 rows), interpolation recording.

Recording can be turned ON/OFF in every points for the following items, alarm printout, scale value printout, scale value tick, and selection of horizontal/vertical printout on trend mode.

● **Chart Speeds**: 1 to 1,500mm/h.

● **Change of Chart Speed (Interval)**: Chart speed or logging interval is changed by remote control signals (optional) or alarm occurrence.

● **Print Cycle Time (Interval)**: Analog recording interval in the trend mode: FIX mode…Recording for interval is same as measuring interval. AUTO mode…Recording interval is determined according to the chart speed.

Digital recording interval in the trend mode: MULTIPLE mode…each channel selectable from any of three values (1 min. to 24 hours). SINGLE mode…chart speed and the number of recording lines automatically determine digital interval.

Interval in the logging mode: MULTIPLE mode…Selected and recorded from one of three interval for each channel (1 min, to 24hours), SINGLE mode…Recorded at a determined interval.

● **Chart Drive**: Pulse motor drive.

● **Chart Speed Accuracy**: ±0.1% (for recording longer than 1m).

● **Start Time**: Programmable for measurement (scan) and printing start time or T LOG interval.

● **Printout Mode**:

1. NORMAL: Printing starts when START/STOP switch turned ON and stops when switch is turned OFF.
2. PRINT ON ALARM (Either one of the following is settable): TRIGGER mode… Printing starts at set alarm*1 ON, and stops at START/STOP switch OFF (set on shipment from the factory). LEVEL mode…Printing starts at set alarm*1 ON, and stops at alarm OFF.
3. CHART SP/INTVL CHANGE ON ALARM: Chart speed/interval changes at set alarm *1ON, and restored at alarm OFF.

   *1 ; All OR alarms or the specified alarm.

● **Standard Printing Functions**: Engineering units (up to 6 alphanumerics), tag number (up to 7 alphanumerics), alarms (channel number, alarm type, and the time of alarm ON/OFF), scale markings (0/100%, 0/50 100%, or 20% steps), program list, manual, message (max. 16 characters), and header (60 characters×5 lines).

## DISPLAY AND CONTROLS

● **Type of Display**: Vacuum fluorescent display (5×7 dot matrix, blue), 2 lines (upper display…20 characters, larger size, lower display…28 characters, smaller size).

● **Data Display**: Measured data (Tag No., channel number, alarm status, measured value, engineering unit), bargraph, clock, alarm status, relay status, programming data, battery status, and recording format

(TREND/LOG).

## CALCULATION (STANDARD)

- **Scaling**: Range···DCV/TC/RTD, input range···each range within the measuring range, scaling range···−20000 to +20000, decimal point···freely settable.
- **Differential Calculation (△T)**: Between any channels (within the same range).
- **Moving Average**: For every 8 scans (ON/OFF is selectable for every channel).

## MEMORY CARD

- **Memory Data**: Setting data, measured data, communication input data and programmed parameter can be stored on a memory card (accessory).
- **Memory Capacity**: 512, 256 or 64K bytes.
- **Data Length (common settings to all channels)**: 500/1,000/2,000/4,000/8,000/16,000/32,000 data/channel, data length: 2 bytes/data.
- **Trigger Conditions**: In Writing······Chart end detection, alarm or external contact input (optional), In Reading···Alarm, external contact (optional).
- **Pre-Trigger**: 0 to 100% (10% step).
- **Output**: Outputs for communication and recording are possible.
- **Battery Backup**: Lithium battery, battery life (512K bytes···approx. 10 months, 256K bytes···approx. 3 years, 64K bytes···5 years).

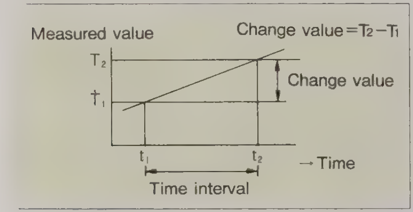
## GROUPING

- **Number of Group Programmings**: Up to 6 groups (programmable for range, alarm, printing format and tag number), channel logging···optional (/MATH).

## ALARMS

- **Number of Alarm Set Levels**: Up to 6 levels/channel.
- **Alarm Types**: High (H), low (L), high-rate of change (RH), low-rate of change (RL), delta high (△H), and delta low (△L).

*high-rate of change (time interval): Measurement cycle×(1 to 15).



- **Recording**:

Trend mode: CH, No., alarm types, and ON/OFF times in the right margin.

Logging Mode: CH. No. and alarm types at the start of measured data.

- **Alarm Outputs (Optional)**: Up to 2 points (internal). AND or OR output as well as REFLASH output can be specified. REFLASH alarm output (500ms) using special internal alarm relay contact.
- **Alarm Acknowledgement**: Pressing the ACK key stops the alarm display flashing and resets the dedicated common relay output.
- **Alarm Reset**: Hold type relay output by pressing the RESET key.
- **Display**: The flashing display can be obtained for 20 point alarm statuses (ch. 1 to 20)+one common point for computing channels (ch. 31 to 60).

## CONSTRUCTION

- **Mounting**: Desk-top or flush panel mounting (may be inclined up to 30° backward from vertical).
- **Dimensions**: Approx. 221 (H)×338 (W)×341.5(D)mm, (8-11/16×13-5/16×13-7/16"), depth with screw input terminal block: 360mm(14-3/16")
- **Weight**: Approx. 9.7kg (213 lbs).

## POWER REQUIREMENTS

- **Power Supply**: 90 to 250V AC (wide voltage range power supply), 50 and 60Hz (must be specified).
- **Power Consumption**: Approx. 80VA.

## NORMAL OPERATING CONDITIONS

- **Ambient Temperature**: 5 to 40°C (40 to 104°F).
- **Humidity Range**: 20 to 80% at 5 to 40°C.
- **Input Source Resistance**: Less than 2kΩ (DC V & TC inputs), less than 10Ω/wire (Pt100), less than 5Ω/wire (Pt50), or less than 1Ω/wire (Cu10).

## GENERAL SPECIFICATIONS

- **Insulation Resistance**: More than 20MΩ at 500V DC between terminals and case.
- **Dielectric Strength**: 1,500V AC for one minute between power line and case, or 1,000V AC for one minute between contact output terminals and case, between measuring terminals and case, between measuring terminals.
- **Battery-Backup Memory**: Lithium battery, maintains all setting data for about 10 years.
- **FAIL Alarm**: FAIL lamp lights up when the recorder is in fail condition (FAIL output signal changes to de-energized).
- **Chart End Detection**: When the chart approaches its end, "CHART" appears on the display. When recording is automatically stopped, the recorder goes into the monitoring status, and the CHART END output relay is energized (transfer contact).
- **Clock**: With calendar function.
- **Key Lock**: KEY LOCK key used for locking setting entries.
- **Input Terminals**: Clamped input terminal block (standard) and screw input terminal block (optional).
- **Wiring**: The input terminal block can be removed from the mainframe for easier wiring.

## STANDARD ACCESSORIES

Chart···1 chart (20m), color ribbon···1 pc., fuse···1 pc. (1.25A), ···1 pc.

## OPTIONAL FEATURES

- **GPIB Interface (/GP-IB)**: Conforms to IEEE St'd 488-1978.
- **RS-232-C Interface (/RS232C)**: Conforms to EIA RS-232-C.
- **Computation (/MATH)**: Types: +, −, ×, ÷, SQR (square root), ABS (absolute, value), LOG (common logarithm), EXP (exponential), Maximum, Minimum, Averages, Totals, Max.−Min., Standard deviation, Logic (AND, OR, NOT, XOR). C LOG. T LOG. Number of channels··· Up to 30 channels.
- **Remote Control (/REM)**: Input signal: TTL level, open collector, and contact status.
- **Internal Alarm Output (/AK-02)**: 2 points, external box: Contact rating: 24V DC0.5A
- **DC Power Source (/DC)**: 10 to 32V DC source.
- **User's Linearization & Remote RJC(/ULN)**:

User's Linearization: Type of user's linearizing: 3 types, (Segmented by 32 points).
Input measuring range: DC V (20mV to 50V, scale span: −20000 to 20000).
Remote RJC (reference junction compensation): Accuracy: (2×accuracy of TC input measurement+temperature difference between the terminal of remote terminal block and remote terminal measuring temperature of TC block at TC range.

- **AC Input (/AC2, /AC6)**:

/AC2: AC V 1 point, AC current 1 point.
/AC6: AC V 3 points, AC current 3 points.
Max. Voltage: 250V or 25V.
Max. Current: 2.5A or 0.25A.
/AC2: Channels of 19 and 20 〔the rest of channels (11 to 18) are used for DC input and high break down voltage solid state relay〕.
/AC6: Channels of 15 to 20 〔the rest of channels (11 to 14) are used for DC input and high break down voltage solid state relay〕.

## MODEL AND SUFFIX CODES

| Model | Suffix Codes | | Description |
|---|---|---|---|
| 3750 | | ························ | Portable hybrid recorder(HR1300) |
| Relay types | 12 | ························ | 10 points/2 s (high breakdown voltage solid state relay) |
| | 22 | ························ | 20 points/2 s (high breakdown voltage solid state relay) |
| Power Requirements | -0 | ···················· | 90 to 250 VAC |
| Frequency | 1 | ············ | 50 Hz |
| | 2 | ············ | 60 Hz |
| Optional Feature | /□ | | Refer to OPTIONAL FEATURES |

## OPTIONAL FEATURES

| Option Code | Description |
|---|---|
| **/GP-IB** | GPIB interface |
| **/RS232C** | RS-232-C interface |
| **/MATH** | Mathematical functions |
| **/REM** | Remote controls |
| **/AK-02** | Alarms(internal, 2 points) |
| **/SIT** | Screw input terminal block |
| **/DF** | °F display |
| **/DC** | DC power source |
| **/ULN** | User's linearization and remote RJC |
| **/AC2** | AC input(voltage 1 input, current 1 point) |
| **/AC6** | AC input(voltage 3 inputs, current 3 points) |

Both /**GP-IB** and /**RS232C** interface cannot be used in a single instrument.
Both AC input /**AC2** and /**AC6** cannot be used in a single instrument.

## OPTIONAL ACCESSORIES

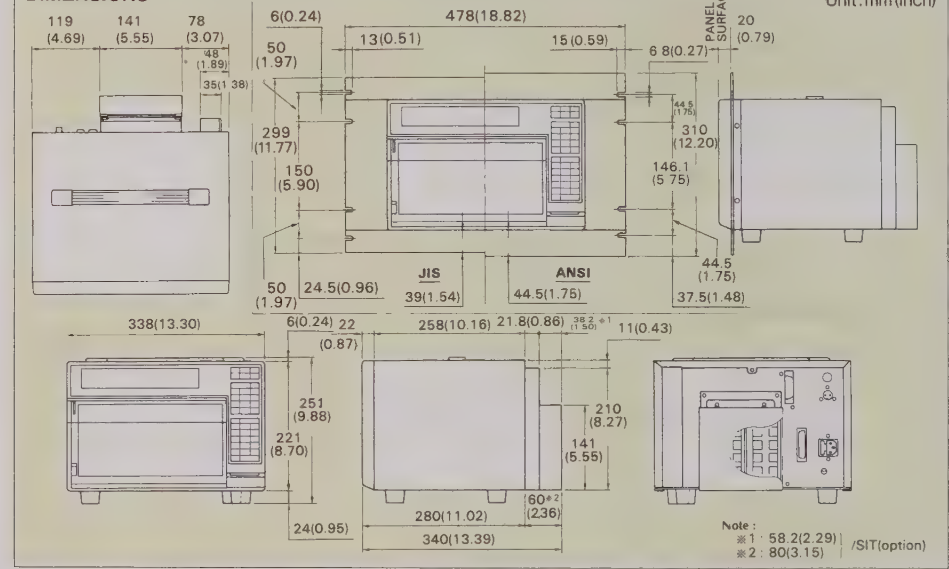
| Code | Name | |
|---|---|---|
| 378903 | Memory card (setting & measured data), 64K bytes | |
| 378904 | Memory card (setting & measured data), 256K bytes | |
| 378905 | Memory card (setting & measured data), 512K bytes | |
| 379801 | Clamped input terminal block (10 points) | |
| 379802 | Screw input terminal block (10 points) | |
| 438920 | Shunt resistor (for clamped input terminal block) | 250Ω ±0.1% |
| 438921 | | 100Ω ±0.1% |
| 438922 | | 10Ω ±0.1% |
| 415920 | Shunt resistor (for screw input terminal block) | 250Ω ±0.1% |
| 415921 | | 100Ω ±0.1% |
| 415922 | | 10Ω ±0.1% |
| 379811 | Rack mounting kit (JIS) | |
| 379813 | Rack mounting kit (ANSI) | |

**379801** Can not be used when /SIT option is specified
**379802** /SIT option must be specified

## SPARES

| Name | Part No. | Description |
|---|---|---|
| Ten-color ribbon | **B9627AZ** | Order q'ty: 1 unit (1 pc./unit) |
| Z-fold chart | **B9855AY** | 20m, 10mm div. on time axis, Order q'ty: 6 units (1 chart/unit) |

## DIMENSIONS



Dimensions differ for models with /SIT option specied.

**YOKOGAWA**

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02

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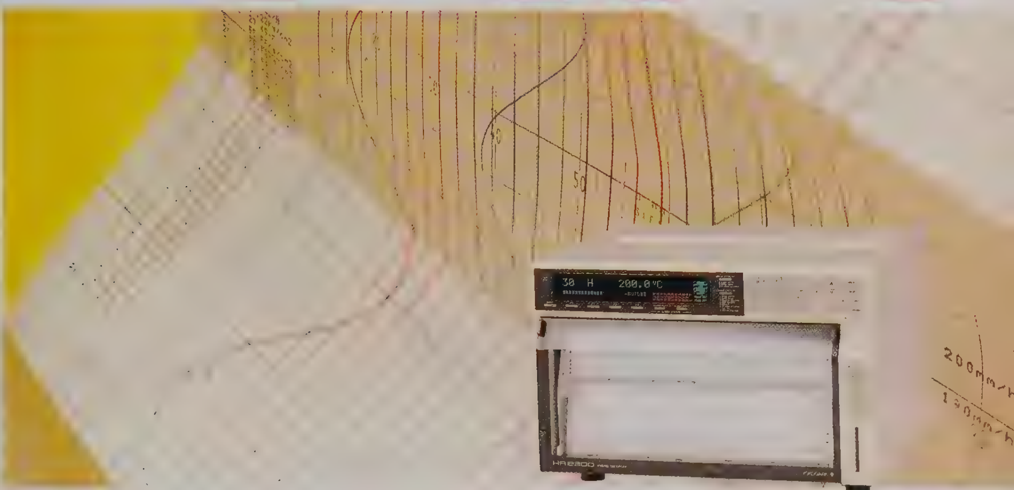
YOKOGAWA

**High-speed scanning of 30 points/s**
**High-speed recording of 60 points/2 s**
**Ten-color analog traces**

# HR

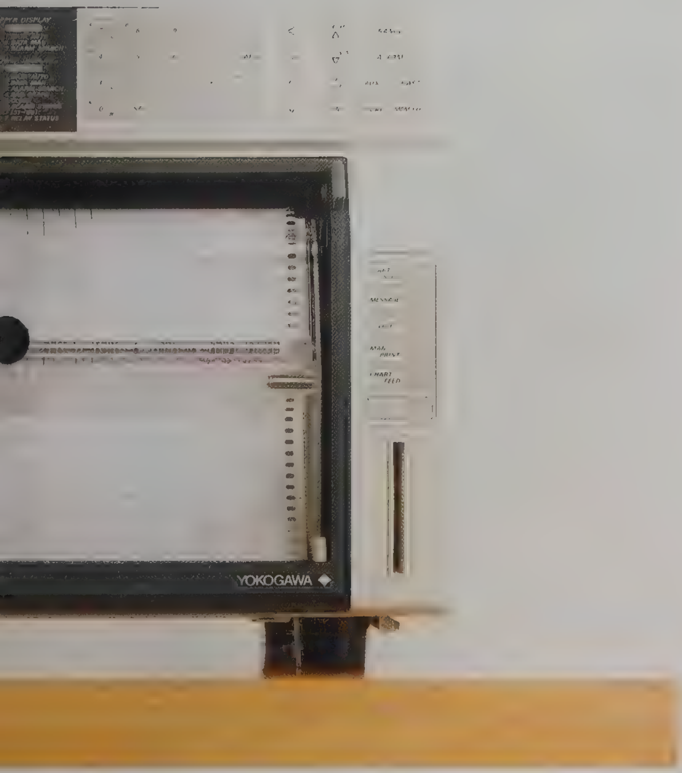


# HYBRID RECORDER HR 2300

Bulletin 3760-E

# Accurate, High-Speed Hybrid Recorder

Ideal for laboratory applications.



The YOKOGAWA HR2300 is a new Hybrid Recorder with high-speed scanning of 30 points/second, and high-speed recording of 60 points/2 seconds.

This interactive menu-driven recorder with it's powerful analytical functions, is ideal for many fields of R&D and laboratory applications.

# HR 2300

### High-Speed Scanning of 30 Points/s
**(High-Speed Model)**

- Provided with a YOKOGAWA-developed high breakdown voltage solid state relay.

### High-Speed Recording of 60 Points/2 s

- 30 points for computation and other features are available in addition to 30 input points.

### Programmable Ten-Color Recorder

- Recording colors can be assigned to designated channels.

### Powerful Computing Functions (Optional)

- +, −, ×, ÷, statistical, logical and relational computation.

### Memory Card (Optional)

- Saving and loading of settings, measured and computed data.

### Computer Friendly (Optional)

- Bidirectional communications via GPIB or RS-232C interface.

### Alarm Functions

- Up to 6 types of alarm set points.

# Maximum Scanning Speed and Relay Life

through the Use of YOKOGAWA-Original Solid State Relay.

### High-Speed Scanning: 30 Points/Second

**30 points/second**
(high breakdown voltage solid state relay)
**30 points/2 seconds**
(high breakdown voltage solid state relay, electromagnetic relay)

Retained analysis is possible because digital data which is sampled every second can be transferred to memory card or to a supervisory computer via a GP-IB or RS-232C interface.

YOKOGAWA has developed a high breakdown voltage solid state relay with the following advantages:

- Higher scanning speed than electromagnetic relay.
- Long relay life. In addition, there is no relay noise.
- YOKOGAWA-original solid state relay has high normal mode breakdown voltage (1,500 V DC), and high common mode breakdown voltage (250 V AC).

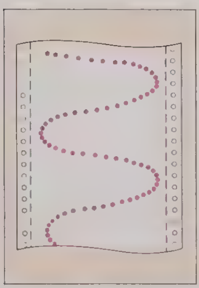
(YOKOGAWA-original high break down solid state relay)

### High-Speed Recording: 60 Points/2 Seconds

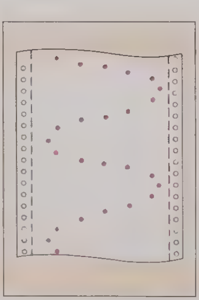
In two seconds, 30 input points – in addition to another 30 points for computed data, digital inputs and memory card data – can be recorded in analog form.

You can select the most important data from a variety of input data, and record it in analog form.

Data analysis is easy because the printout density is higher than conventional models.



HR2300



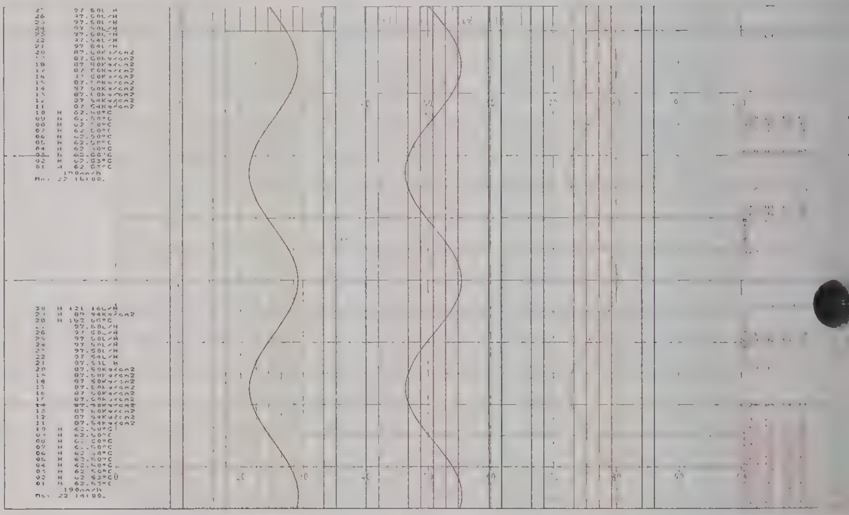
Model 3081

### Ten-Color Recording

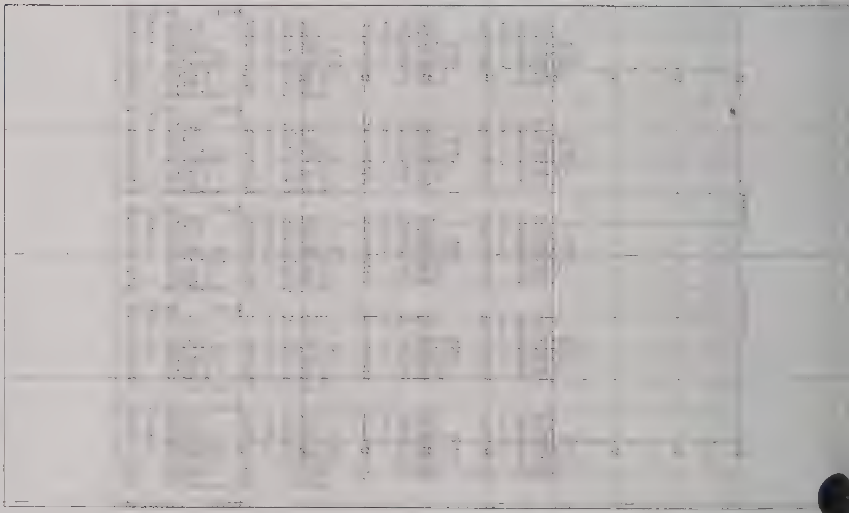
Each channel is recorded in one of ten distinct colors; black, blue, navy blue (new), green, yellowisch green (new), purplish red (new), brown, orange (new), red and purple.

Zone recording, partially expanded-scale printout, message printout, Tag No., header printout (80 characters × 5 lines) are also selectable.

● Color can easily be designated for each channel.



● The most important measurement data can be quickly identified with selected colors



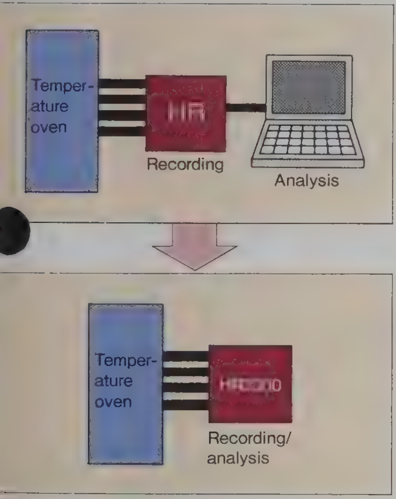
● LOGGING printout

# Full Line of Convenient Features....

## Computing, Memory Card, Communication and Alarm Functions.

### Multiple Computing Functions (Optional)

It features the following computing functions: +, −, ×, ÷, SQR, absolute value, common logarithm, and exponential computation, relational computation (<, >, =, ≠), TLOG (maximum, minimum, average, and total values and the difference between the maximum and the minimum values can be determined as time-series data in the specified channel), CLOG (maximum, minimum, average, and total values, the difference between the maximum and the minimum values, and standard deviation can be determined in a specified channel group).



### AC Inputs (Optional)

The following AC inputs can be measured without using converter.

/AC 2: AC V 1 point, AC current 1 point.
/AC 6: AC V 3 points, AC current 3 points.
Max. Voltage: 250V or 25V.
Max. Current: 2.5A or 0.25A.

### Universal Input Types

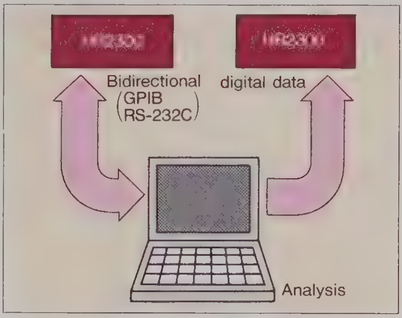
- DC Voltages : 20 mV to 50 V DC
- TC : Type R, S, B, K, E, J, T, N, W, L, U, and KP vs Au7Fe
- RTD : Pt100, JPt100 (1mA), Pt100 (2mA), Pt50 (2mA), Ni100 (SAMA, DIN), Ni120, J263∗B, and Cu10.
  High-sensitivity model (0.01% resolution for each Pt100 and JPt100 range) is also available.
- Contact status for event recording
- The above four types of inputs are freely selectable for each point.
- DC A: Shunt resistor (accessory) must be used.

### Memory Card

- Large memory capacity of 512K bytes
- Data is composed of two bytes
- Data saving to the memory card can be started :
  - From the front panel
  - Alarm occurrence
  - By contact inputs at the rear
  - Out of chart
- Both setting and measured data can be stored
- Data prior to an alarm occurrence can also be collected using the pre-trigger functions.

### Computer Friendly (Optional)

- Analog recording is also possible by transmitting digital data from a personal computer (/MATH required).
- Both data transfer from an HR2300 to a personal computer, and data setting to an HR2300 from a personal computer are available (bidirectional communications).



### Wide Voltage Range Power Supply

90 to 250 V AC.

### DC Power Source (Optional)

10 to 32V DC power source.

### Hourly, Daily, or Monthly Report (Optional)

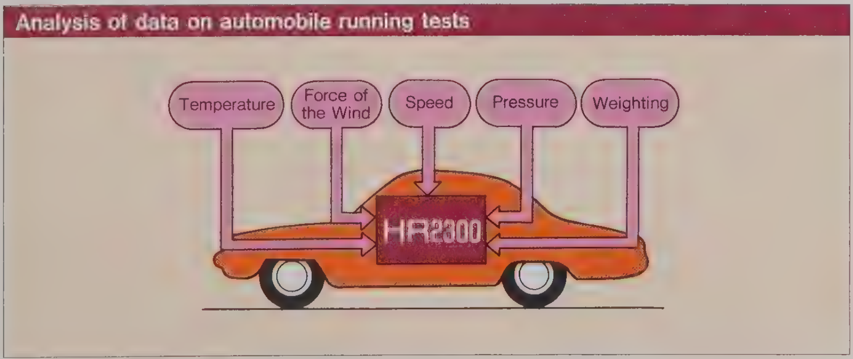
Summary of computations such as max., min., average, total values. can be printed.

### Multiple Alarm Functions

Alarm types : High(H), low(L), delta high(ΔH), delta low(ΔL), high-rate of change(RH),
low-rate of change(RL).
Alarm recording : Recorded at the right end of the chart.
△01 H1 10:20 (△mark: red), alarm ON,
▽01 H1 9:20 (▽mark: blue), alarm OFF,
channel No., alarm type, alarm level, time of alarm occurrence.

### Alarm Output Relay (Optional)

Internal alarm relay: 12 points, externel alarm relay: 60 points.
AND/OR and Reflash alarm relay output.

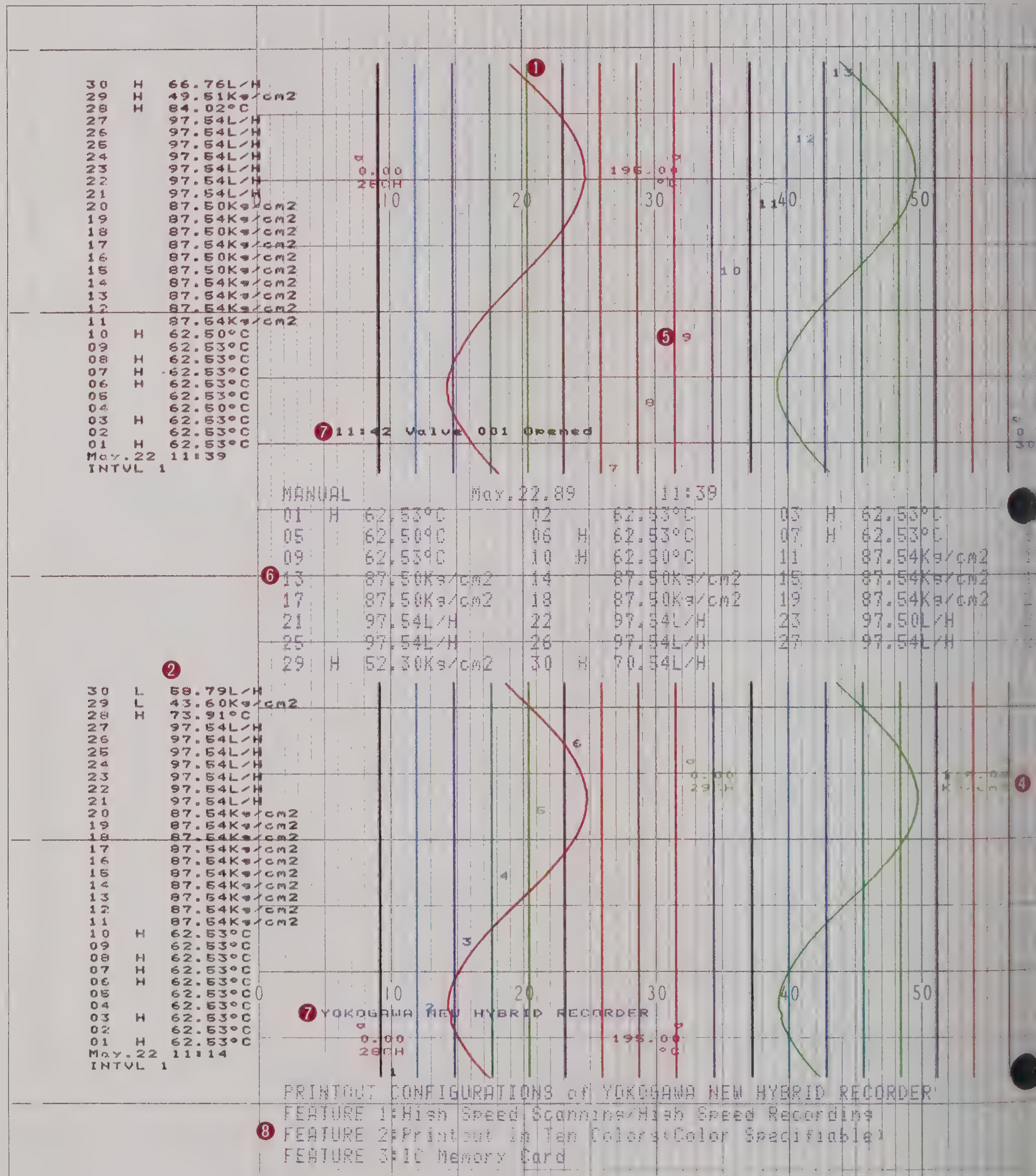

Analysis of data on automobile running tests

- **High accuracy : ±0.05% of rdg + 2 digits (2 V range)**
- **ΔT measuring, scaling function**
- **Highly visible vacuum fluorescent display**
- **Internal illumination for quick chart reading (optional)**
- **Versatile optional features and accessories**

  GP-IB, RS-232C interface, remote control, mathematical functions, internal alarm output relay, external alarm output relay, memory card, reporting, user's linearization and remote RJC.

# Ten-Color Hybrid Recorder....

Any Color can be Assigned for Each Channel.



```
30   H   66.76L/H
29   H   49.51Kg/cm2
28   H   84.02°C
27       97.54L/H
26       97.54L/H
25       97.54L/H
24       97.54L/H
23       97.54L/H
22       97.54L/H
21       97.54L/H
20       87.50Kg/cm2
19       87.54Kg/cm2
18       87.50Kg/cm2
17       87.54Kg/cm2
16       87.50Kg/cm2
15       87.50Kg/cm2
14       87.54Kg/cm2
13       87.54Kg/cm2
12       87.54Kg/cm2
11       87.54Kg/cm2
10   H   62.50°C
09       62.53°C
08   H   62.53°C
07   H   62.53°C
06   H   62.53°C
05       62.53°C
04       62.50°C
03   H   62.53°C
02       62.53°C
01   H   62.53°C
May.22  11:39
INTVL  1
```

⑦ 11:42 Valve 001 Opened

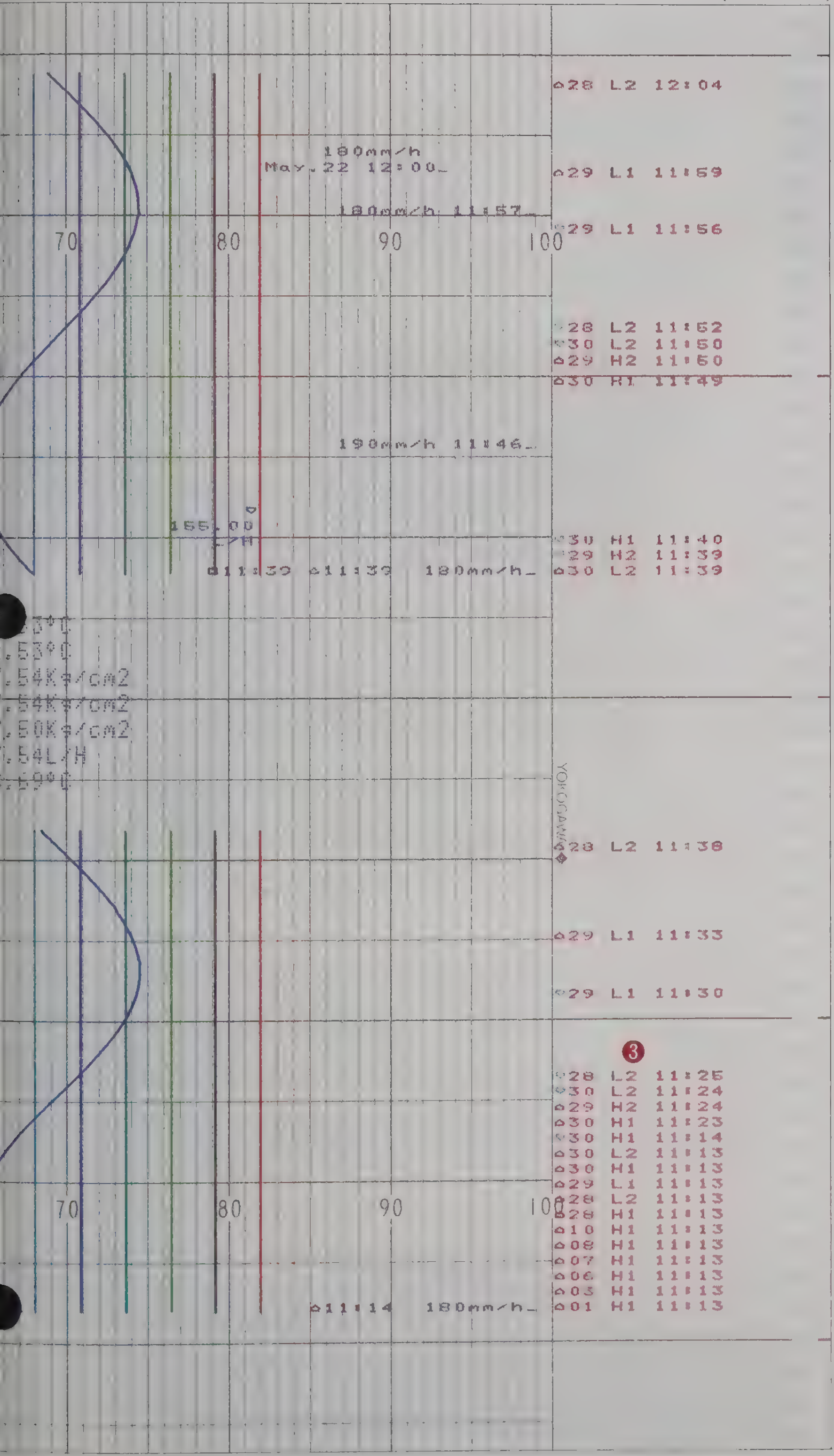
```
MANUAL            May.22.89          11:39
01  H  62.53°C       02      62.53°C        03  H  62.53°C
05     62.50°C       06  H   62.53°C        07  H  62.53°C
09     62.53°C       10  H   62.50°C        11     87.54Kg/cm2
13     87.50Kg/cm2   14      87.50Kg/cm2    15     87.54Kg/cm2
17     87.50Kg/cm2   18      87.50Kg/cm2    19     87.54Kg/cm2
21     97.54L/H      22      97.54L/H       23     97.50L/H
25     97.54L/H      26      97.54L/H       27     97.54L/H
29  H  52.30Kg/cm2   30  H   70.54L/H
```

```
30   L   58.79L/H
29   L   43.60Kg/cm2
28   H   73.91°C
27       97.54L/H
26       97.54L/H
25       97.54L/H
24       97.54L/H
23       97.54L/H
22       97.54L/H
21       97.54L/H
20       87.54Kg/cm2
19       87.54Kg/cm2
18       87.54Kg/cm2
17       87.54Kg/cm2
16       87.54Kg/cm2
15       87.54Kg/cm2
14       87.54Kg/cm2
13       87.54Kg/cm2
12       87.54Kg/cm2
11       87.54Kg/cm2
10   H   62.53°C
09       62.53°C
08   H   62.53°C
07   H   62.53°C
06   H   62.53°C
05       62.53°C
04       62.53°C
03   H   62.53°C
02       62.53°C
01   H   62.53°C
May.22  11:14
INTVL  1
```

⑦ YOKOGAWA NEW HYBRID RECORDER

```
PRINTOUT CONFIGURATIONS of YOKOGAWA NEW HYBRID RECORDER
FEATURE 1:High Speed Scanning/High Speed Recording
FEATURE 2:Printout in Ten Colors(Color Specifiable)
FEATURE 3:IC Memory Card
```

(Actual size)



### ● Relation of Chart Speed and Printing

(Digital printout; SINGLE Mode)

| Chart Speed (mm/h) | CH No./ Tag No. | Date & Hr. Chart Speed Measured Data | Alarm Scale value Message (Title) |
|---|---|---|---|
| 1 to 9 | Printable | Non printable | Printable |
| 10 to 500 | Printable | Printable | Printable |
| 501 to 1,500 | Non printable | Non printable | Non printable |

### ● Printing Intervals of Digital Data

(Analog recording & digital printout; SINGLE Mode)

| Chart Speed (mm/h) | Printing intervals of digital data | | | |
|---|---|---|---|---|
| | 1 line | 2 line | 3 line | 4 line |
| 10 to 24 | 12 h | 6 h | 4 h | 3 h |
| 25 to 49 | 4 h | 2 h | 1-2/3h | 1 h |
| 50 to 99 | 2 h | 1 h | 40 min | 30 min |
| 100 to 500 | 1 h | 30 min | 20 min | 15 min |

### ❶ Analog data

Input signals of up to 60 channels are printed out at specified intervals in ten colors in the calibrated width of 250mm (9-7/8″). (Color can be assigned to designated channel)

### ❷ Digital printout

Measured data, date and time, hour and alarm status are printed in digital form at specified intervals (recording periods). 3 types of intervals can be programmed for each channel (Interval: MULTIPLE Mode).

### ❸ Alarm printout

At the time of alarm ON and OFF, the channel No., alarm type, and time are printed.

### ❹ Scale values printout

The scale values are printed for each channel every 5.0mm or 12.5mm in the same color as the analog data.

### ❺ Tag No. (or channel No.) printout

Tag No. (or channel No.) is printed at regular intervals in the same color as the analog data.

### ❻ Manual printout

When MAN PRINT key is depressed, digital data of single scan is printed out in place of analog printout.

### ❼ Message printout

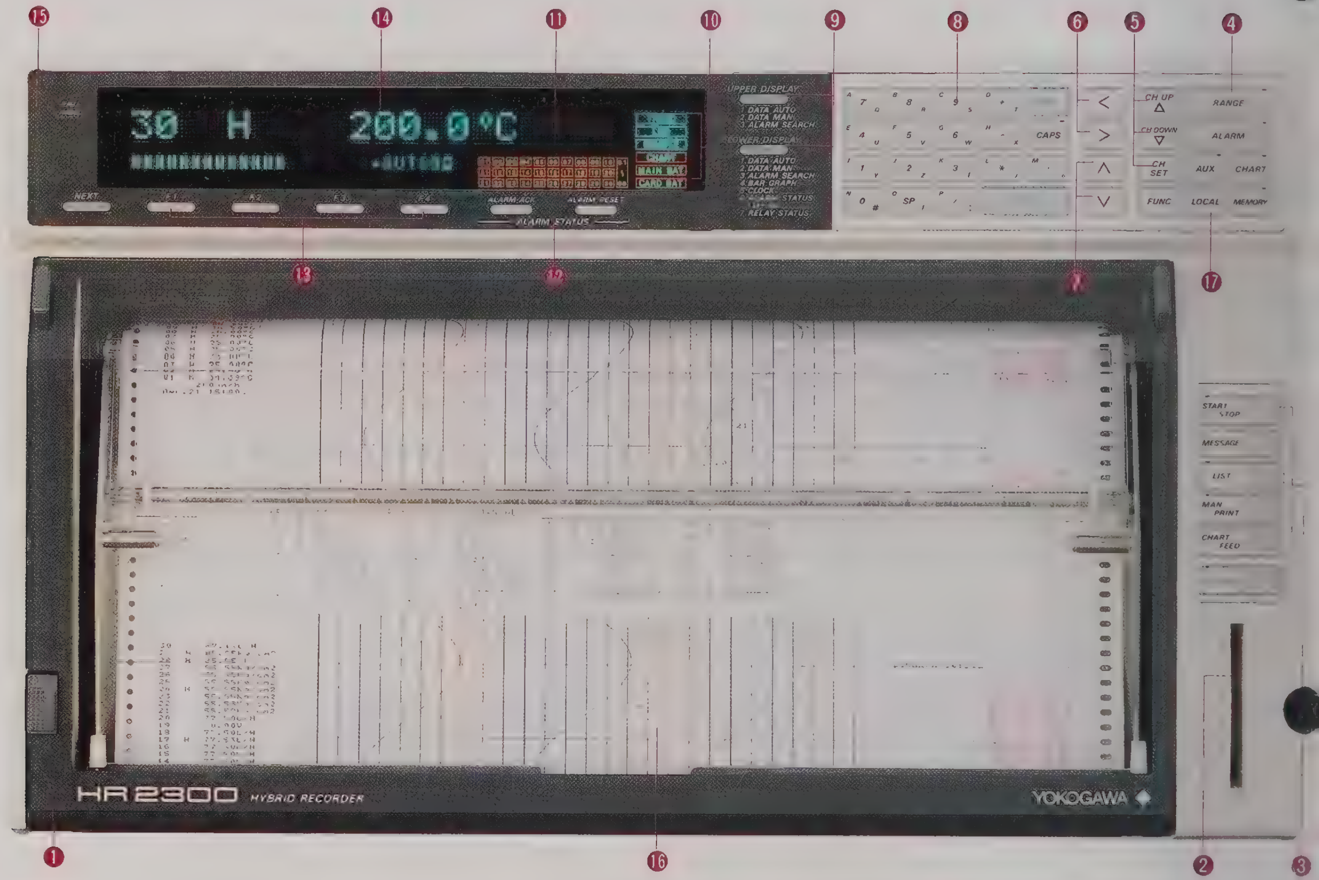
The message contents are printed when periodical printout (title), depressing FUNC Key, external signal input or alarm ON.

### ❽ Header printout

Header information (80 characters × 5 lines) can be printed out through panel key switch.

# Easy-to-Operate Design

## Interactive Menu-Driven Setting with Large Multiple VFD Display.



**❶Power ON/OFF selector**

**❷Memory card slot**

**❸Recording mode keys**

START/STOP: Start or stop of the chart drive.

HEADER: Used for header printout.

LIST: Used for program list printout.

MAN PRINT: Single-scan printing in logging format.

CHART FEED: Feeds the chart at a push of this key.

KEY LOCK: Used for locking setting entries.

**❹Setting mode keys**

Programming mode keys to select RANGE, ALARM, CHART SPEED or memory card.

**❺Channel number selection keys**

**❻Cursor keys**

**❼Setting mode moving keys**

**❽Alphanumeric keys**

**❾Display mode keys**

UPPER DISPLAY···Upper display mode changing key.

LOWER DISPLAY···Lower display mode changing key.

DATA AUTO···Display is automatically updated in 2s intervals.

DATA MAN···Displays the data of a designated channel.

ALARM SEARCH···Displays the channel data on alarm in 2s intervals.

BAR GRAPH···Measured data is shown on the LOWER DISPLAY as a bargraph.

CLOCK···Displays the date and time.

ALARM STATUS (31 to 60)···Displays the alarm status for each channel.

RELAY STATUS···Displays the alarm output relay status (internal: 12 points, external: 60 points, etc).

**❿Recorder mode display area**

Lights up to indicate recording mode (TREND, LOGGING), out of chart and low battery condition and REMOTE status for GP-IB communication.

**⓫Alarm status display area**

Displays alarm status of measurement or computation channel.

**⓬ALARM STATUS selection keys**

ALARM ACK: Alarm display flashes when alarm occurs. Press ALARM ACK to display current alarm status.

ALARM RESET: ALARM status display and alarm output relay is reset.

**⓭Programming function keys**

Simple programming with interactive display.

**⓮Measuring and setting display area**

UPPER DISPLAY, LOWER DISPLAY

**⓯Recorder FAIL lamp**

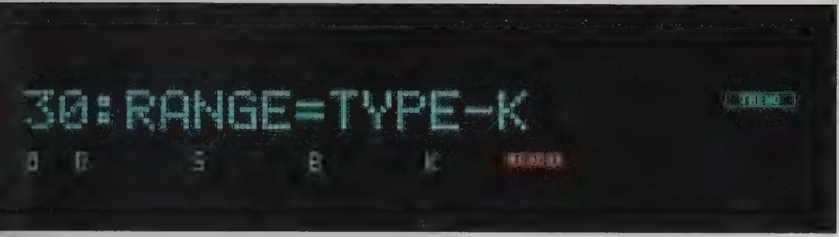
**⓰Recorded chart**

**⓱LOCAL key**

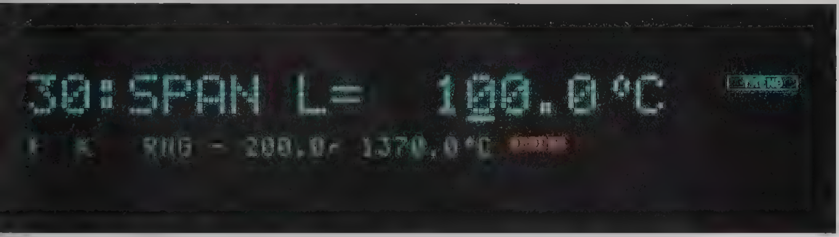
Switches the GP-IB communication from REMOTE to LOCAL.

### Setting Display

nteractive setting: Function key labels appear on the LOWER display.



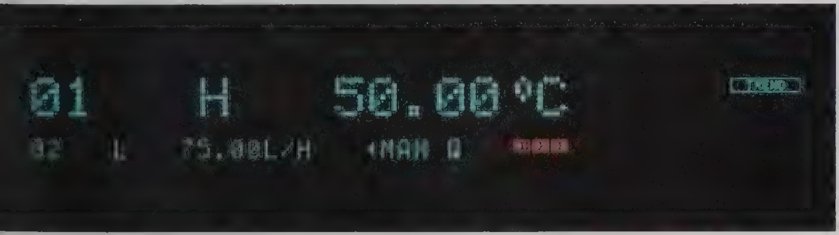
The display shows the setting range.



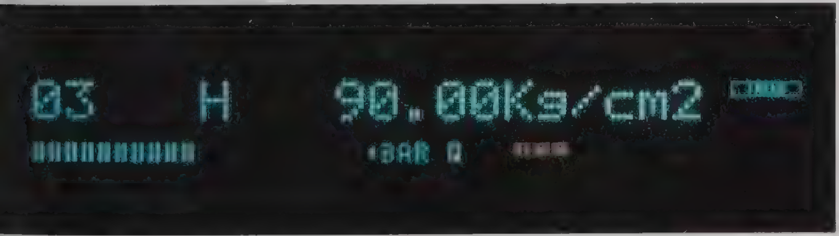
### Measurement Display

### ariety of display modes are selectable.

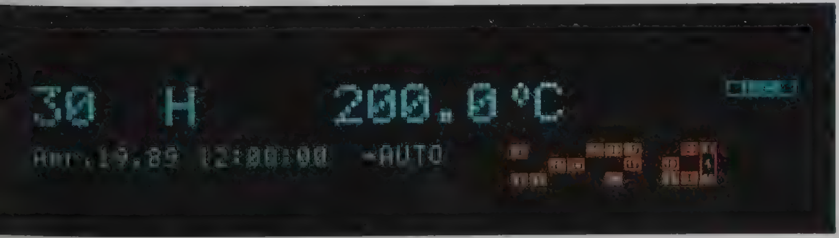
Both UPPER and LOWER DISPLAYs show the measurement data in digital format.



The UPPER DISPLAY shows the measurement data in digital format and LOWER DISPLY, a bargraph.

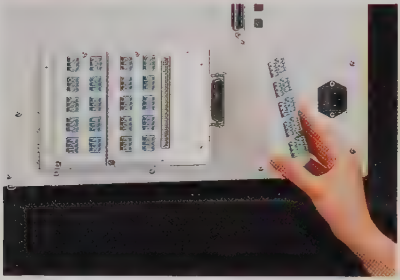


The UPPER DISPLAY shows the measurement data in digital format, and the LOWER DISPLAY, the clock.



## *Simple Operation*

### Clamped Input Terminals Block

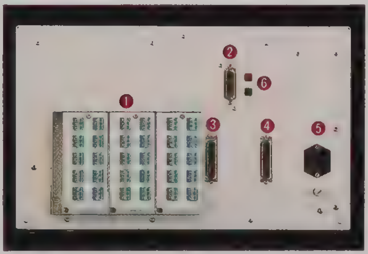


The clamped input terminal block can be removed for wiring. (You can specify another type, screw input terminal block)

### Easy Chart Replacement

The chart replacement can be easily carried out by using a new chart cassette.

### Rear Panel



❶Input terminal block
❷GPIB or RS-232C interface terminal
❸FAIL, chart end, remote terminal, alarm output relay terminal (/AK-02)
❹Alarm output relay terminal (/AK-12)
❺Power connector
❻Interface for external alarm output relay (/EAI)

# SPECIFICATIONS

## MEASUREMENTS

- **Number of Inputs**: Up to 20 or 30 points.
- **Input Types, Ranges, Accuracy and Resolution:**

At 23±2°C and 55±10 % R.H.
∗Any of DC V, TC, RTD, and DI inputs can be selected for each input point.

| Input Type | Range | Measurement (Digital display & printout) | |
|---|---|---|---|
| | | Accuracy | Resolution |
| DC V | 20mV | ±(0.05% of rdg+5 digits) | 1μV |
| | 60mV | ±(0.05% of rdg+2 digits) | 10μV |
| | 200mV | ±(0.05% of rdg+2 digits) | 10μV |
| | 2V | ±(0.05% of rdg+2 digits) | 100μV |
| | 6V | ±(0.05% of rdg+2 digits) | 1mV |
| | 20V | ±(0.05% of rdg+2 digits) | 1mV |
| | 50V | ±(0.05% of rdg+2 digits) | 10mV |
| TC | ∗1 R<br>∗1 S | ±(0.05% of rdg+1°C)<br>R,S:0 to 100°C ±3.7°C<br>100 to 300°C ±1.5°C<br>B:400 to 600°C ±2°C | 0.1°C |
| | ∗1 B | | |
| | ∗1 K | ±(0.05% of rdg+0.7°C)<br>−200 to −100°C<br>±(0.05% of rdg+1°C) | 0.1°C |
| | ∗1 E<br>∗1 J<br>∗1 T | ±(0.05% of rdg+0.5°C)<br>J, L:−200 to −100°C<br>±(0.05% of rdg+0.7°C) | |
| | ∗2 L<br>∗2 U | | |
| | ∗3 N | ±(0.1% of rdg+0.7°C) | 0.1°C |
| | ∗4 W | ±(0.1% of rdg+1°C) | |
| | ∗5 KP vs Au7Fe | ±(0.05% of rdg+0.7K) | 0.1K |
| RTD | ∗6 Pt100 (1mA, 2mA)<br>∗6 JPt100 (1mA, 2mA) | ±(0.05% of rdg+0.3°C) | 0.1°C |
| | ∗7 Pt50 (2mA) | ±(0.05% of rdg+0.3°C) | |
| | ∗8 Ni 100 (1mA)<br>∗8 Ni 120 (1mA) | ±(0.05% of rdg+0.3°C) | 0.1°C |
| | ∗9 J263∗B | ±(0.05% of rdg+0.3K) | 0.1K |
| | Cu10 GE, L&N WEED, BAILEY | ±(0.2% of rdg+0.7°C) | 0.1°C |
| | Pt100 (1mA)<br>Pt100 (2mA)<br>JPt100 (1mA)<br>JPt100 (2mA) | High-sensitivity model<br>±(0.05% of rdg+0.3°C) | 0.01°C |
| Contact Status (input signal:contact status or DC V) | | | |

∗1 R,S,B,K E,J,T
ANSI IEC 584 DIN IEC 584
JIS C 1602-1981
∗2 L Fe-CuNi DIN 43710
J Cu-CuNi DIN 43710
∗3 N Nicros.I-Nisi.
IEC 584 DIN IEC 584
∗4 W W·5%Re-W·26%Re
Hoskins Mfg Co
∗5 KP vs Au7Fe NBS Vo. 76A
∗6 Pt100 JIS C 1604-1989. JIS C 1606 1989
IEC 751 DIN IEC 751
JPt100 JIS C 1604-1989 JIS C 1606-1989
∗7 Pt50 JIS C 1604-1981. JIS C 1606-1984
∗8 Ni100 SAMA DIN 43760
Ni120 McGRAW EDISON
∗9 J263∗B(Pt-Co) YOKOGAWA

- **Recording Accuracy (Analog trend)**: ±0.1% of span (not including measurement accuracy).
- **Recording Resolution (Analog trend)**: 0.04% of span.
- **Reference Junction Compensation Error**: ±1°C (R, S, B, W), ±0.5°C (K, J, E, T, N, L, U, KP vs Au7Fe)
- **Scan Cycle Time**: 1 to 60s selectable (1, 2, 3, 4, 5, 6, 10, 12, 15, 20, 30, 60s).
- **Scanning Rate**: 60ms/channel.
- **A-D Integration Time**: 20ms (50Hz), 16.7 ms (60Hz), and 100ms (50/60Hz) are selectable via an internal DIP switch.
- **Input Impedance**: More than 10MΩ on 2V or lower ranges and TC, Approx. 1MΩ on 6V or higher ranges.
- **Input Bias Current**: Less than 10nA.
- **TC Burnout Protection**: 2kΩ or less (normal), 100kΩ or more (open), current approx. 6μA, detection pulse width approx 2ms, (ON or OFF selectable for each channel).
- **Temperature Coefficient**: Zero drift; 0.01 % of range/°C, Full span; 0.01% of range/°C.
- **Maximum Allowable Input Voltage**: 60V DC.
- **Maximum Common Mode Voltage**: 250 Vrms AC.
- **Common Mode Rejection**: More than 120 dB (50 or 60Hz±0.1%).
- **Normal Mode Rejection**: More than 40 dB (50 or 60Hz±0.1%).

## PRINTOUT

- **Printing Technique**: Raster scan using a wire-dot printer and a 10-color ribbon.
- **Effective Recording Span**: 250mm (analog data).
- **Chart**: Z-fold chart (342.5mm×30m) with calibrated width of 250mm.
- **Recording Colors**: Analog data (TREND mode)···10 colors (black, blue, navy blue, green, yellowisch green, purplish red, brown, orange, red and purple), Color can be specified for every channel. Digital data (TREND mode) ··· channel number, measured data, date & time, chart speed (black), alarm (ON mark; red, OFF mark; blue), (LOG & LIST modes) ··· all data (purple).
- **Recording Accuracy**: Measurement accuracy +(±0.1% of effective recording span).
- **Printout Format**: Analog trend/analog trend+digital/logging.

In the trend mode···the following recording is available.

Zone recording, partially expanded-scale printout assignable for every points.

In the trend mode, recording can also be turned ON/OFF in every channel for the following items (panel setting), Analog recording, measured value printing (1 to 4 rows), interpolation and moving average recording.

- **Chart Speeds**: 1 to 1,500mm/h.
- **Change of Chart Speed (Interval)**:

Chart speed or logging interval is changed by remote control signals (optional) or alarm occurrence.

- **Print Cycle Time (Interval)**:

Analog recording interval in the trend mode: FIX mode···Recording for interval is same as measuring interval (data is recorded every two scans in 1s scanning). AUTO mode···Recording interval is determined in accordance with the chart speed.

Digital recording interval in the trend mode: MULTIPLE mode···selectable each channel from any of three values (1 min. to 24 hours). SINGLE mode···chart speed and the number of recording lines automatically determine digital interval.

Interval in the logging mode: MULTIPLE mode···Chosen and recorded from one of three types of interval for every channel (1 min, to 24 hours), SINGLE mode··· Recorded at a determined interval.

- **Chart Drive**: Pulse motor drive.
- **Chart Speed Accuracy**: ±0.1% (for recording longer than 1m).
- **Start Time**: Programmable for measurement (scan) and printing start time or T LOG interval.
- **Printout Mode**:

1. NORMAL: Printing starts when START STOP switch turned ON and stops when switch is turned OFF.
2. PRINT ON ALARM (Either one of following is settable): TRIGGER mode Printing starts at set alarm∗1 ON, and stops at START/STOP switch OFF (set on shipment from the factory). LEVEL mode···Printing starts at set alarm∗1 ON, and stops at alarm OFF.
3. CHART SP/INTVL CHANGE ON ALARM: Chart speed/interval changes at set alarm ∗1ON, and restored at alarm OFF.

∗1; All of the OR alarms or the set alarm.

- **Standard Printing Functions**: Engineering units (up to 6 alphanumerics) tag number (up to 7 alphanumerics), alarms (channel number, alarm type, and the time of alarm ON/OFF), scale markings (0/100%, 0/50/100%, or 20% steps), program list, manual, message (max. 16 characters), and header (80 characters×5 lines).

## DISPLAY AND CONTROLS

- **Type of Display**: Vacuum fluorescent display (5×7 dot matrix, blue), 2 lines (upper display···20 characters, larger size. lower display···28 characters, smaller size).
- **Data Display**: Measured data (channel number, alarm status, measured value engineering unit), bargraph, clock, al status, relay status, programming d battery status, and recording format (TREND/LOG).

## CALCULATION (STANDARD)

- **Scaling**: Range···DCV/TC/RTD, input range···each range within the measuring range, scaling range···−20000 to +20000, decimal point···freely settable.

- **Difference Calculation (△T)**: Between any channels (within the same range).
- **Moving Average**: For every 8 scans (ON/OFF is selectable for every channel).

## MEMORY CARD

- **Memory Data**: Setting data, measured data, communication input data and programmed parameter can be stored on a memory card (accessories).
- **Memory Capacity**: 512, 256 or 64K bytes.
- **Data Length (common settings to all channels)**: 500 / 1,000 / 2,000 / 4,000 / 8,000 / 16,000/32,000 data/channel, data length: 2 bytes/data.
- **Trigger Conditions**: In Writing······Chart end detection, alarm or external contact input (optional), In Reading···Alarm, external contact (optional).
- **Pre-Trigger**: 0 to 100% steps.
- **Output**: Outputs for communication and recording are possible.
- **Battery Backup**: Lithium battery, battery life (512K bytes···about 10 months, 256K es···about 3 years, 64K bytes···5 years).

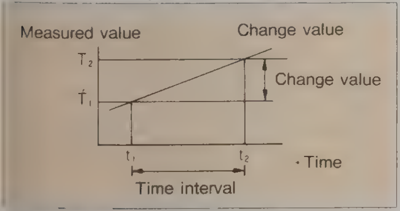
## GROUPING

- **Number of Group Programmings**: Up to 6 groups (programmable for range, alarm, printing format and tag number), channel logging···optional (/MATH).

## ALARMS

- **Number of Alarm Set Levels**: Up to 6 levels/channel.
- **Alarm Types**: High (H), low (L), high-rate of change (RH), low-rate of change (RL), delta high (△H), and delta low (△L).

*high-rate of change (time interval): Measurement cycle×(1 to 15).



- **Recording**:

Trend mode: CH, No., alarm types, and ON/OFF times in the right margin.

Logging Mode: CH. No. and alarm types at the start of measured data.

- **larm Outputs (Optional)**: Up to 12 points ernal), up to 60 points [separate case (s)]. AND or OR output as well as REFLASH output can be specified. REFLASH alarm output (500ms) using special internal alarm relay contact.
- **Alarm Acknowledgement**: Pressing the ACK key stops the alarm display flashing and resets the dedicated common relay output.
- **Alarm Reset**: Hold type relay output by pressing the RESET key.
- **Display**: The flashing display can be obtained for 30 point alarm statuses (ch. 1 to 30)+one common point for computing channels (ch. 31 to 60).

## CONSTRUCTION

- **Mounting**: Desk-top or flush panel mounting (may be inclined up to 30° backward from vertical).
- **Dimensions**: Approx. 438 (W)×266 (H)×415 (D)mm, (17-1/4×10-1/2×16-3/8").
- **Weight**: Approx. 15kg (33.0 lbs).

## POWER REQUIREMENTS

- **Power Supply**: 90 to 250V AC (wide voltage range power supply), 50 and 60Hz (must be specified).
- **Power Consumption**: Approx. 110VA(230V).

## NORMAL OPERATING CONDITIONS

- **Ambient Temperature**: 5 to 40°C (40 to 104°F).
- **Humidity Range**: 20 to 80% at 5 to 40°C.
- **Input Source Resistance**: Less than 2kΩ (DC V & TC inputs), less than 10Ω/wire (Pt 100Ω), less than 5Ω/wire (Pt 50Ω), or less than 1Ω/wire (Cu 10Ω).

## GENERAL SPECIFICATIONS

- **Insulation Resistance**: More than 20MΩ at 500V DC between terminals and case.
- **Dielectric Strength**: 1,500V AC for one minute between power line and case, or 1,000V AC for one minute between contact output terminals and case, between measuring terminals and case, between measuring terminals.
- **Battery-Backup Memory**: Lithium battery, maintains all setting data for about 10 years.
- **FAIL Alarm**: FAIL lamp lights up when the recorder is in fail condition (FAIL output signal changes to non-inductive).
- **Chart End Detection**: When the chart reaches near its end, "CHART" appears on the display. When recording is automatically stopped, the recorder goes into the monitoring status, and the CHART END output relay is energized (transfer contact).
- **Clock**: With calendar function.
- **Key Lock**: KEY LOCK key used for locking setting entries.
- **Internal illumination**: Fluorescent lamp (optional).
- **Input Terminals**: Clamped input terminal block (standard) and screw input terminal block (optional).
- **Wiring**: The input terminal block can be removed from the mainframe for easier wiring.

## STANDARD ACCESSORIES

Chart···1 chart (30m), color ribbon···1 pc., fuse···1 pc. (1.25A), power supply cord···1 pc., rack mounting kit···1 pc.

## OPTIONAL FEATURES

- **GPIB Interface (/GP-IB)**: Conforms to IEEE St'd 488-1978.
- **RS-232C Interface (/RS232C)**: Conforms to EIA RS-232C.
- **Computation (/MATH)**:

Functions: +, −, ×, ÷, SQR (square root), ABS (absolute, value), LOG (common logarithm), EXP (exponential), Maximum, Minimum, Averages, Totals, Max. −Min., Standard deviation, Logic (AND, OR, NOT, XOR). C LOG. T LOG. Number of channels···Up to 30 channels.

- **Remote Control (/REM)**:

Input signal: TTL-level, open collector, and contact status.

- **Internal Alarm Output (/AK-□□, /EAI)**:

2 or 12 points, external box: Max. 30 or 60 points (external alarm box), contact rating: 30V AC, 2A (internal alarm). 240V AC, 1A. (external alarm). The length of life: 300K contact.

- **DC Power Source (/DC)**: 10 to 32V DC Power Source.
- **User's Linearization & Remote RJC (/ULN)**:

**User's Linearization**: Type of user's linearizing: 3 types, No. of sequenced lines: 32 lines, Input measuring range: DC V (20mV to 50V, span: −20000 to 20000)

**Remote RJC (reference junction compensation)**: Accuracy: (2 × accuracy of TC input measurement + temperature difference between the terminal of remote terminal block and remote terminal measuring temperature of TC block at TC range.

- **Hourly, Daily, or Monthly Report (/RPT)**:

Computation: max., min., average, total values.

Reporting function is executed with the interruption of analog recording.

- **AC Input (/AC 2, /AC 6)**:

/AC 2: AC V 1 point, AC current 1 point.
/AC 6: AC V 3 points, AC current 3 points.
Max. Voltage: 250V or 25V.
Max. current: 2.5A or 0.25A.

**/AC 2**: Channels of 29 and 30 [the rest of channels (20 to 28) are used for DC input & high break down solid state relay scanners].

**/AC 6**: Channels of 25 to 30 [the rest of channels (20 to 24) are used for DC input & high break down solid state relay scanners].

**Note**: Both /AC 2 and /AC 6 are available only for 2s input models.

## MODEL AND SUFFIX CODES

| Model | | Suffix Codes | | Description |
|---|---|---|---|---|
| 3760 | | ……… | ……… | Hybrid recorder(HR2300) |
| No. of Inputs & Relay Types | 20 | ……… | ……… | 20 points/2 s, (electromagnetic relay) |
| | 21 | ……… | ……… | 20 points/1 s, (high breakdown voltage solid state relay) |
| | 22 | ……… | ……… | 20 points/2 s, (high breakdown voltage solid state relay) |
| | 30 | ……… | ……… | 30 points/2 s, (electromagnetic relay) |
| | 31 | ……… | ……… | 30 points/1 s, (high breakdown voltage solid state relay) |
| | 32 | ……… | ……… | 30 points/2 s, (high breakdown voltage solid state relay) |
| Power requirements | | -0 | ……… | 90 to 250 V AC |
| Frequency | | -1 | ……… | 50 Hz |
| | | -2 | ……… | 60 Hz |
| Optional features | | | /□ | Refer to Optional Features |

## OPTIONAL FEATURES

| Option Code | Description |
|---|---|
| /GP-IB | GPIB interface |
| /RS232C | RS-232C interface |
| /MATH | Mathematical functions |
| /REM | Remote controls |
| /AK-02 | Alarms(internal, 2 points) |
| /AK-12 | Alarms(internal, 12 points) |
| /SIT | Screw input terminal block |
| /EAI | Interface for external alarm relay<br>(for **379101** and **379102** only) |
| /LMP | Internal illumination |
| /DF | °F display |
| DC | DC power source |
| /RPT | Hourly, daily or monthly report |
| ULN | User's linearization and Remote RJC |
| AC2 | AC input (AC voltage 1 point, AC current 1 point) |
| AC6 | AC input (AC voltage 3 points, AC current 3 points) |

## OPTIONAL ACCESSORY

| Code | Name | |
|---|---|---|
| 378903 | Memory card(setting & measured data), 64K bytes | |
| 378904 | Memory card(setting & measured data), 256K bytes | |
| 378905 | Memory card(setting & measured data), 512K bytes | |
| * 379101 | External alarm output relay, 30 points | |
| * 379102 | External alarm output relay, 60 points | |
| 378981 | Rack mounting kit for **3760** (ANSI & JIS) | |
| 379801 | Clamped input terminal block (10 points) | |
| 379802 | Screw input terminal block (10 points) | |
| 438920 | Shunt resistor (For clamped input terminal block) | 250 Ω ±0.1% |
| 438921 | | 100 Ω ±0.1% |
| 438922 | | 10 Ω ±0.1% |
| 415920 | Shunt resistor (For screw input terminal block) | 250 Ω ±0.1% |
| 415921 | | 100 Ω ±0.1% |
| 415922 | | 10 Ω ±0.1% |
| B9857ZD | Cable for external alarm ( 1m) | |
| B9857ZE | Cable for external alarm ( 2m) | |
| B9857ZF | Cable for external alarm ( 5m) | |
| B9857ZG | Cable for external alarm (10m) | |

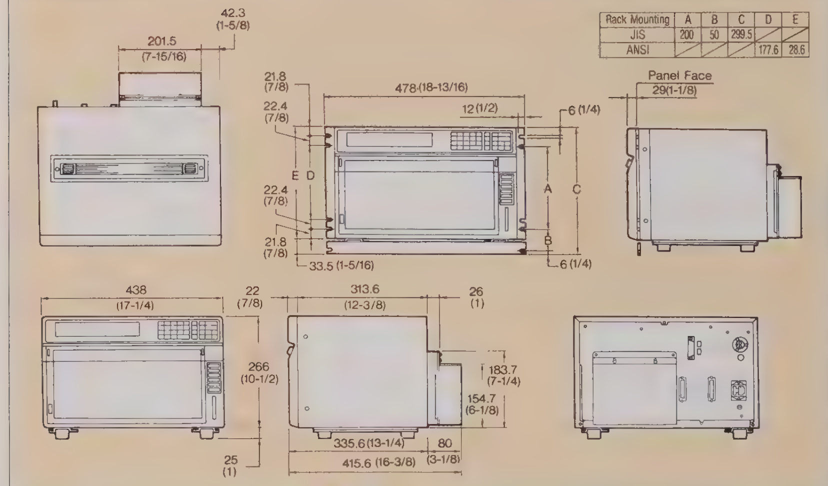
*Specify an optional feature of **/EAI** when the HR2300 mainframe is used with external alarm output relay.

## SPARES

| Part No. | Name |
|---|---|
| B9627AZ | Ten-color ink ribbon |
| B9627RY | Z-fold chart(30m), 10mm div. on time axis |
| B9627AY | Z-fold chart(30m), 25mm div. on time axis |

## DIMENSIONS

Unit: mm(apporox. inch)



| Rack Mounting | A | B | C | D | E |
|---|---|---|---|---|---|
| JIS | 200 | 50 | 299.5 | | |
| ANSI | | | | 177.6 | 28.6 |

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# Low-Cost Recorders for OEM and Lab Users

Non-contact ultrasonic pen-position transducer and brushless DC servomotor mean long-term reliability

YOKOGAWA

Bulletin 3021-01E

# MODEL 3021 FLATBED PEN RECORDER

Model 3021 Flatbed Pen Recorder is a one- or two-pen 250mm strip chart recorder with a ±0.25% accuracy. It uses the mess-free, disposable felt-tip ink pens, and records on Z-fold or roll chart. Input ranges are provided in 12 steps from 10mV to 50V full scale, or single ranges.
Model 3021 offers exceptionally high reliability and advanced performance.

**Main Features**

- High accuracy—±0.25% of full scale (250mm)
- One- or two-pen model
- Z-fold or roll chart recording
- 12 input ranges from 10mV to 50V full scale, or single range
- Compact, low-profile construction
- Visible recording and note-taking convenience on a flatbed table
- Consistently stable chart drive by pulse motor and crystal oscillator
- 8 pushbutton selected chart speeds—60cm/min to 2cm/h with an accuracy of ±0.25%
- Simple, quick pushbutton operation

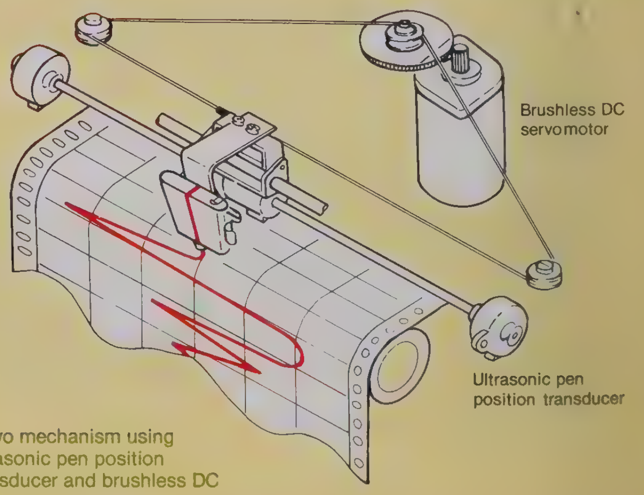
## *Special Features Common to Models 3021 & 3022*

### Maximum reliablity and increased operating life through the use of non-contact servo elements

In the servo system of Models 3021 and 3022, we have combined the best of both an entirely new, YEW-designed non-contacting ultrasonic pen position transducer and wear-free brushless DC servomotor. This system completely eliminates noisy and troublesome slidewires, potentiometers, and motor brushes, resulting in greater reliability and longer maintenance-free operating life than other recorders.

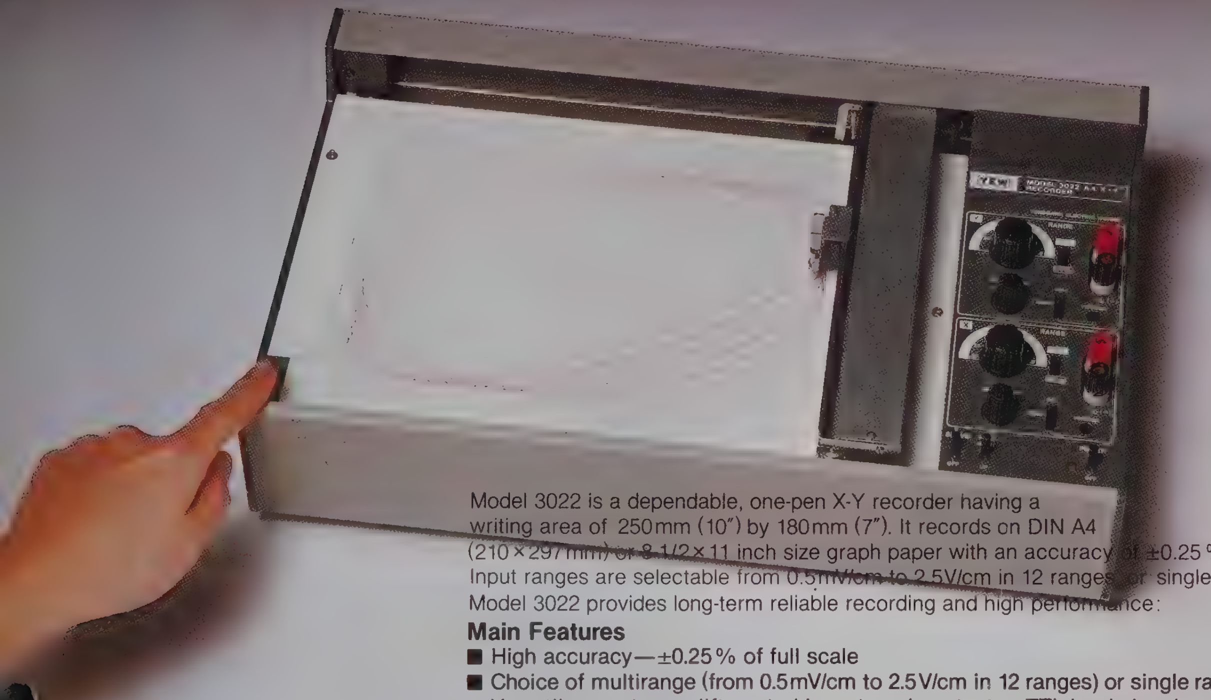
**■ Ultrasonic pen position transducer**

The ultrasonic pen position transducer utilizes magnetostriction—an electromotive force generated and propagated at the speed of ultrasonic waves by deformation of a material having magnetostrictive properties. The pen position is automatically measured from the propagation time of an ultrasonic longitudinal wave (pulse) in a magnetostrictive delay line. Ultrasonic pulses are generated by a transmitter coil (on the writing pen) and sensed by two detector coils, through which the magnetostrictive line passes.



Servo mechanism using ultrasonic pen position transducer and brushless DC servomotor

# MODEL 3022 A4 X-Y RECORDER

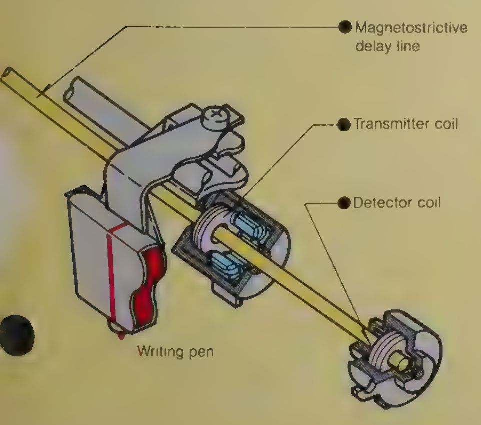


Model 3022 is a dependable, one-pen X-Y recorder having a writing area of 250mm (10″) by 180mm (7″). It records on DIN A4 (210×297mm) or 8-1/2×11 inch size graph paper with an accuracy of ±0.25%. Input ranges are selectable from 0.5mV/cm to 2.5V/cm in 12 ranges or single ranges. Model 3022 provides long-term reliable recording and high performance:

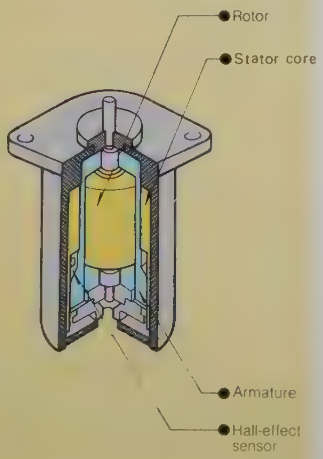
**Main Features**

- High accuracy—±0.25% of full scale
- Choice of multirange (from 0.5mV/cm to 2.5V/cm in 12 ranges) or single range
- Versatile remote pen lift control by external contact or TTL-level signal
- Bench-top or rack-mounting (using an optional rack adaptor)
- Easy-to-change paper holddown
  Paper loading and unloading is quick and simple. Releasing a click button securely clips the graph paper to the table. The paper can be unloaded by depressing the click button.
- Compact and lightweight—mere 102mm (4″) thick
  Model 3022 measures less than 438×267×102mm (17-1/4×10-1/2×4″), and weighs only 6.7kg (14.8 lbs).

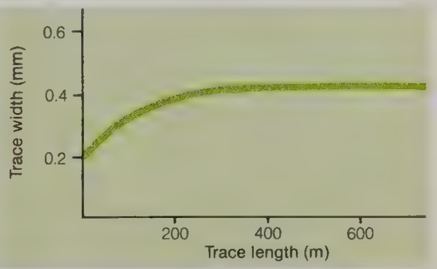
■ Ultrasonic pen position transducer



■ Brushless DC servomotor



## Disposable quick-change felt pens for excellent line quality



Disposable pens can be replaced in seconds without messy ink handling, and without soiling the operator's hands. Replacement is simple—just pull up the spent cartridge from the pen holder and slip on a new one.

You can choose three different colors of disposable felt-tip pen cartridge—red, green or blue. All pens provide consistent quality, clear, clean, crisp traces. Cap-off period of pen cartridges is longer than 10 days.

## SPECIFICATIONS

| Model | 3021 | 3022 |
|---|---|---|
| **Instrument name** | Flatbed pen recorder | A4 X-Y recorder |
| **Drive system** | Automatic null-balancing DC servo mechanism with brushless DC servomotor and ultrasonic pen position transducer | |
| **Full scale, or writing area** | 250 mm | 250 mm × 180 mm (10"×7") |
| **Number of pens** | 1 or 2 (red for 1st pen, green for 2nd pen) | 1 (red) |
| **Writing system** | Ink writing using disposable felt-tip pen cartridges | |
| **Accuracy** | ±0.25% of full scale on 500 mV range, at 23 ± 2°C | ±0.25% of full scale on 25 mV/cm range, at 23 ± 2°C |
| **Deadband** | Less than ±0.1% of full scale | |
| **Pen speed (nominal)** | 500 mm/s max. | X-axis 300 mm/s max.,<br>Y-axis 500 mm/s max. |
| **Pen lift** | Manual, remote (optional) | Electrical (local or remote) |
| **Chart** | Z-fold chart (280 mm × 15 m), or roll chart (280 mm × 20 m), with calibrated width of 250 mm | DIN A4 and (8-1/2 × 11") size graph paper |
| **Paper holddown** | ——— | Mechanical |
| **Chart drive** | Pulse motor drive using crystal oscillator (chart speed accuracy... ±0.25%) | ——— |
| **Chart speeds** | 2, 6, 20, 60 cm/min. and cm/h | ——— |
| **Input ranges** | 10, 20, 50, 100, 200, 500 mV, 1, 2, 5, 10, 20, 50 V full scale (12 calibrated ranges), or single range | 0.5, 1, 2.5, 5, 10, 25 mV/cm, 0.05, 0.1, 0.25, 0.5, 1, 2.5 V/cm (12 calibrated ranges plus continuous vernier), or single range |
| **Zero set** | Independently adjustable for each pen over full scale | |
| **Input impedance** | Approx. 1 MΩ constant on all input ranges | |
| **Common mode rejection** | More than 120 dB at line frequency, or at DC | |
| **Normal mode rejection** | More than 50 dB at line frequency | More than 40 dB at line frequency |
| **Power requirements** | 90 to 110 V, 100 to 130 V, 180 to 220 V, or 200 to 250 V AC (must be specified), 48 to 63 Hz | |
| **Power consumption (approx.)** | 22 VA max., 16 VA balanced (one-pen),<br>30 VA max., 22 VA balanced (two-pen) | 30 VA max., 22 VA balanced |
| **Dimensions (approx.)** | 435 (W) × 353 (D) × 192 (H) mm, 17-1/8 × 13-7/8 × 7-5/8" | 438 (W) × 267 (D) × 102 (H) mm, 17-1/4 × 10-1/2 × 4" |
| **Weight (approx.)** | One-pen... 8 kg (17.6 lbs), two-pen... 9 kg (19.8 lbs) | 6.7 kg (14.8 lbs) |

Note: Model 3021... Special input range(s) such as 1 mV full scale are available upon request.

## OPTIONAL FEATURES

| Function | Option Code | Description | Compatible model |
|---|---|---|---|
| Remote Chart Drive Control | **/CHC** | Remort controls of chart speed and chart drive START/STOP | **3021** |
| Event Marker | **/MAK** | Remote control of event marker and Remote Chart Drive Control | |
| Remote Pen Lift Control | **/LIFT** | Remote control of pen lift and Remote Chart Drive Control | |
| Time Base | **/TIME** | Sweep rates: 0.25, 0.5, 1, 2.5, 5, 10 s/cm & min/cm (accuracy... ±2%, linearity... ±0.5%) | **3022** |
| Inch Calibration | **/INCH** | Input ranges: 1 mV/inch to 5 V/inch | |
| Metric Scale | **/MSC** | Centimeter-ruled scales for both X and Y axes | |
| English Scale | **/ESC** | Inch-ruled scales for both X and Y axes | |

Note: For OEM, other optional features than above are available on request.
Examples: special panel color, and user's logo.

## OPTIONAL ACCESSORIES

| Function | Code | Description | Compatible model |
|---|---|---|---|
| Rack adapter | **302901** | For ANSI or JIS size rack | **3022** |
| Dust cover | **302902** | | **3021** |
| | **302903** | | **3022** |

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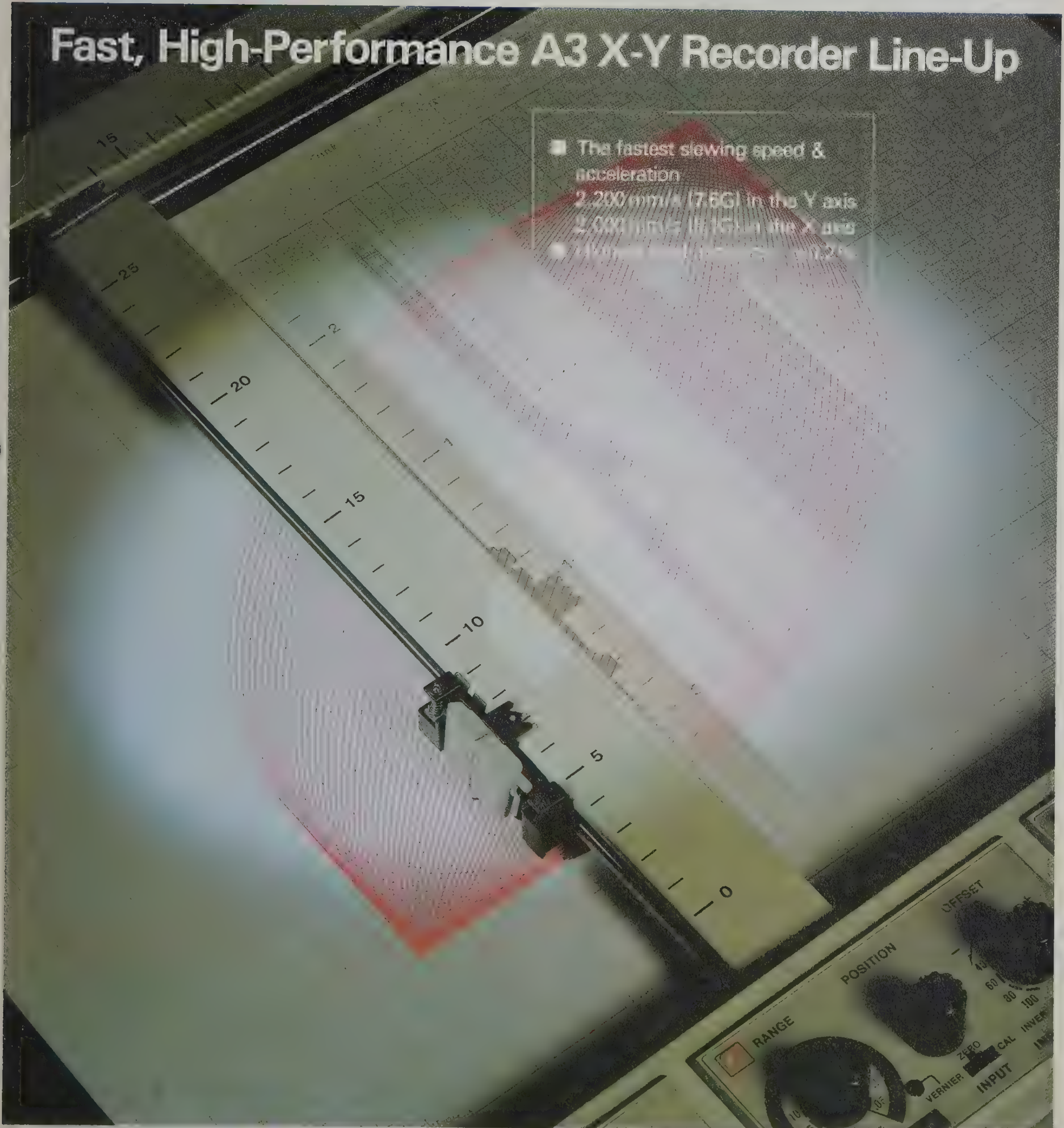
**Bulletin**

# 3023 & 3024
# X-Y RECORDERS



## Fast, High-Performance A3 X-Y Recorder Line-Up

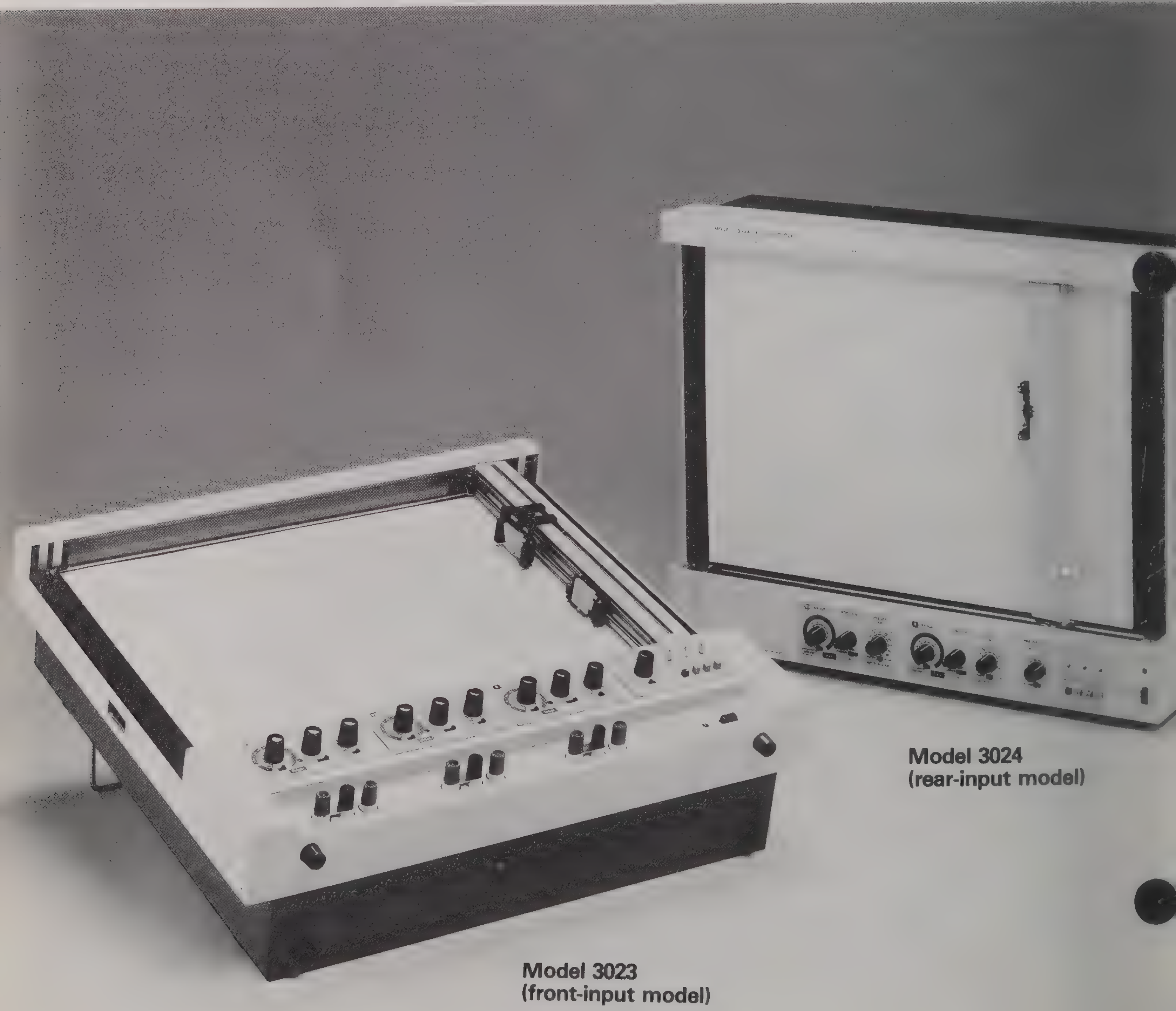
- The fastest slewing speed & acceleration
  2,200 mm/s (7.6G) in the Y axis
  2,000 mm/s ([illegible]) in the X axis
- [illegible]

**YOKOGAWA**

# New, fastest A3 X-Y recorder line-up with excellent price/performance advantage.

Models 3023 and 3024 are top-level, high performance A3 X-Y recorder line-up, available as a front- or rear-input model, and a one- or two-pen model. All models offer the fastest slewing speed and acceleration. The slewing speed and acceleration of the one-pen model in the Y axis is 2,200 mm/s 7.6G, and 2,000 mm/s 5.1G in the X axis.

To assure precision recording of fast-changing signals, Model 3023 & 3024 features include excellent phase and frequency characteristics. In order to provide maximum operator convenience, these X-Y recorders are equipped with easy-to-use, felt-tip pen cartridges, a 10-position offset input dial, 16 speeds of internal time base, versatile remote control functions, and more.



**Model 3024**
**(rear-input model)**

**Model 3023**
**(front-input model)**

# Specifications

**Drive System:** Automatic null-balancing DC servo mechanism.

**Writing Area (Effective Recording Span):** X-axis 381 mm (15"), Y-axis 254 mm (10").

**Number of Pens:** 1 or 2.

**Writing System:** Ink writing using disposable felt-tip pen cartridges.

**Ink Colors:** Red for $Y_1$ 1st pen, green for $Y_2$ 2nd pen.

**Basic Accuracy:** ±0.2% of effective recording span (including non-linearity and dead band) at 23±5°C on 25 mV/cm range.

**Error between Ranges:** Less than ±0.1% of pen deflection.

**Dead Band:** Less than 0.1% of effective recording span.

**Slewing Speed (Nominal):** X-axis 2,000 mm/s, Y-axis 2,200 mm/s.

**Acceleration (Nominal):** One-pen model ... X-axis 5.1G, Y-axis 7.6G, two-pen model ... X-axis 4.5G, Y-axis 7.0G.

**Pen Lift:** All pens simultaneously lifted or lowered by PEN UP-DOWN switch on the front panel, or by an external contact or TTL-level signal.

**Chart Paper:** A3 size graph paper, or roll chart (optional chart drive unit required).

**Paper Holddown:** Electrostatic paper holddown with LED spot paper alignment.

**Type of Input:** Front **(3023)** or rear **(3024)** input. Floating, guarded and shielded (polarity reversal switch on the front panel).

**Input Ranges:** 50μV/cm, 0.1, 0.25, 0.5, 1, 2.5, 5, 10, 25, 50 mV/cm, 0.1, 0.25, 0.5, 1, 2.5, 5 V/cm (16 calibrated ranges plus continuous vernier between ranges).

**Zero Set:** Adjustable to any point on the writing area.

**Input Impedance:** Approx. 1MΩ constant on all input ranges.

**Maximum Source Resistance:** 10kΩ.

**Zero Stability (Nominal):** ±(1.5μV+0.02% of effective recording span)/°C.

**Maximum Allowable Input Voltage (Continuous):** 50V DC on 50μV/cm to 50mV/cm ranges, 250V DC on 0.1V/cm to 5V/cm ranges.

**Maximum Common Mode Voltage:** 250Vrms AC, or 350V DC **(3023)**, 130Vrms AC, or 180V DC **(3024)**.

**Common Mode Rejection:** More than 140dB at power line frequency or at DC.

**Normal Mode Rejection:** More than 50dB.

**Offset Input:** Selectable to ±20, ±40, ±60, ±80, ±100cm (10 ranges) or 0 (OFF) by front panel dial.

**Accuracy of Offset Input:** ±0.2% of offset setting range.

**Temperature Drift of Offset Input:** ±100ppm/°C.

**Time Base (Standard):** Sweep rates ... 0.25, 0.5, 1, 2.5, 5, 10, 25, 50 s/cm & min/cm (accuracy: ±0.5%), Pens automatically lifted after sweep or reset. Trial sweep available with pens lifted.

**Operating Position:** Horizontal, vertical or inclined.

**Operating Temperature Range:** 5 to 40°C (41 to 104°F).

**Humidity Range:** 40 to 80% relative humidity.

**Dielectric Strength:** 1,500V AC **(3023)**, or 1,000V AC **(3024)** for one minute between power line and case, and between input-guard terminals and case.

**Insulation Resistance:** More than 100MΩ at 500V DC between power line and case, and between input-guard terminals and case.

**Power Requirements:** 100, 115, 200 or 230V AC (must be specified), for both 50 and 60Hz.

**Power Consumption (Approx.):**

| Model | Maximum | Balanced |
|---|---|---|
| One-pen model | 210 VA | 70 VA |
| Two-pen model | 250 VA | 80 VA |

**Weight:** One-pen model ... approx. 17 kg (37.5 lbs), two-pen model ... approx. 18 kg (39.7 lbs).

## Available Models

| Model | Description | |
|---|---|---|
| **302313** | Front input | One-pen model |
| **302323** | | Two-pen model |
| **302413** | Rear input | One-pen model |
| **302423** | | Two-pen model |

## Optional Feature

| Option Code | Function | Compatible Models |
|---|---|---|
| **/FRT** | Writing table protection cover | **3023**<br>**3024** |

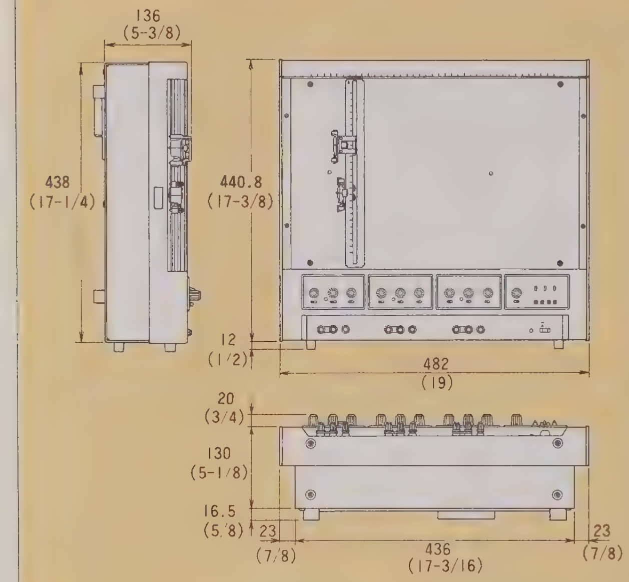
## Optional Accessories

| Name | | Code | Compatible Models |
|---|---|---|---|
| Chart drive unit | | **308941** | **3023, 3024** |
| *Rack adapter | Metric | **303571** | **3023, 3024** |
| | Inch | **303572** | |

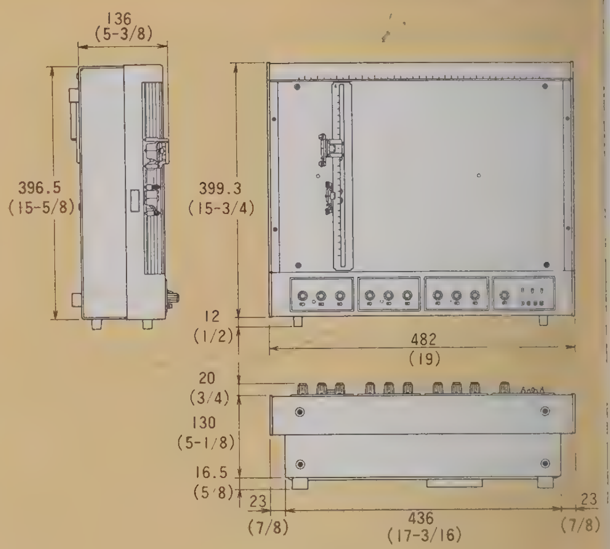
*Note: Rack adapter is required to rack-mount the **3023** or **3024** with **308941**.

## Dimensions

Unit: mm (approx. inch)



**Model 3023**
(Front-panel input,
two-pen model)



**Model 3024**
(Rear-panel input,
two-pen model)

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Bulletin

# 3025
# X-Y RECORDER

## Fast, High-Performance A4 X-Y Recorder

- High drawing speed & high acceleration
  2,000 mm/s² [illegible] in the Y axis
  3,000 mm/s² [illegible] in the X axis

YOKOGAWA

# New, fast A4 X-Y recorder with excellent price/performance advantage.

Model 3025 is a fast, high-performance A4 X-Y recorder, available as a one- or two-pen model. Both models offer high slewing speed and high acceleration. The slewing speed and acceleration of the one-pen model in the Y axis is 2,200 mm/s 7.6G, and 2,000 mm/s 5.1G in the X axis.

To assure precision recording of fast-changing signals, Model 3025 features include excellent phase and frequency charracteristics. In order to provide maximum operator convenience, the X-Y recorder is equipped with easy-to-use, felt-tip pen cartridges, a 10-position offset input dial, 16 speeds of internal time base (optional), versatile remote control functions, and more.

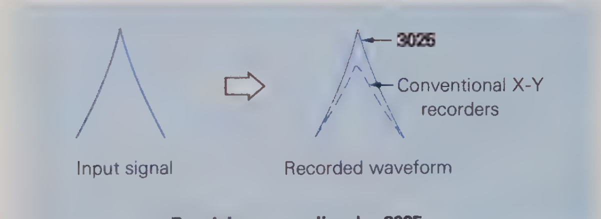
## Outstanding Features

**■ Fast pen response — slewing speed of 2,200 mm/s in the Y axis, 2,000 mm/s in the X axis**

The use of high-torque DC servomotor and new pen mechanism results in high slewing speed and excellent phase characteristics.

**■ High acceleration — 7.6G in the Y axis and 5.1G in the X axis (one-pen model)**

Two-pen model is of 7.0G in the Y axis, and 4.5G in the X axis. By combining high slewing speed and high acceleration, Model 3025 can follow fast-changing input signals.



**Precision recording by 3025**

**■ High-quality traces by using disposable, quick-change felt-tip pen cartridges, and by a light-weight pen mechanism**

Disposable pens provide excellent line quality, and allows simple, one-step replacement without messy ink handling.

**■ ±0.25% accuracy, 50 μV/cm max. sensitivity**

**■ Quick, convenient operation**

All controls are neatly and logically arranged on the front panel, and are easy to use. Major design features include the addition of convenient servo ON/OFF and polarity reversal switches, and preamplifiers separated from the input terminals for safety input wiring. The noise performance is excellent, so that these models eliminate the low-pass filter switch.

**■ Trouble-free electrostatic paper holddown with back-lighted LED for accurate paper alignment**

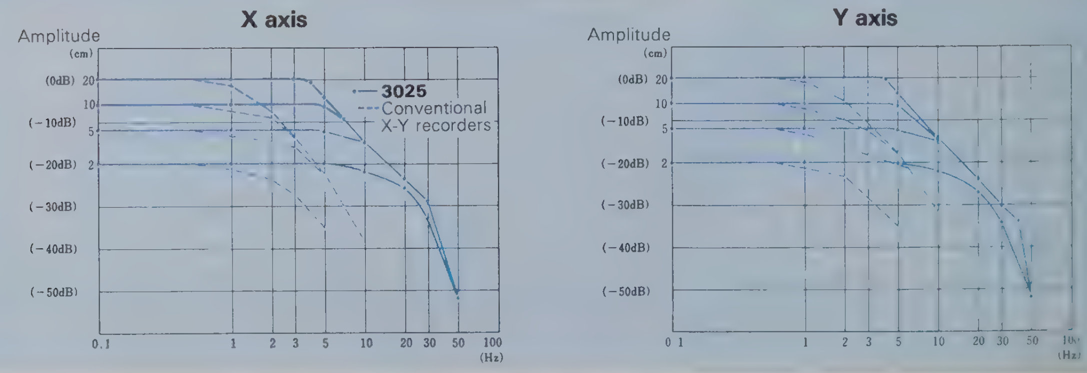
**■ 10 scales of calibrated offset (standard), 16 speeds of time base (optional)**

**■ Versatile remote controls**

As a standard feature, Model 3025 provides remote controls of sweep start and reset, and pen lift by external contact or TTL-level signals. Remote control of chart drive START/STOP and chart speed is also available when used with an optional chart drive unit.

**■ Excellent frequency characteristics**

**Frequency characteristics**



# Specifications

**Drive System:** Automatic null-balancing DC servo mechanism.

**Writing Area (Effective Recording Span):** X-axis 254 mm (10"), Y-axis 180 mm (7-1/8").

**Number of Pens:** 1 **(302513)**, or 2 **(302523)**.

**Writing System:** Ink writing using disposable felt-tip pen cartridges.

**Ink Colors:** Red for $Y_1$ 1st pen, green for $Y_2$ 2nd pen.

**Basic Accuracy:** ±0.25% of effective recording span (including non-linearity and dead band) at 23±5°C on 50 mV/cm range.

**Error between Ranges:** Less than ±0.1% of pen deflection.

**Dead Band:** Less than 0.1% of effective recording span.

**Slewing Speed (Nominal):** X-axis 2,000 mm/s, Y-axis 2,200 mm/s.

**Acceleration (Nominal):** One-pen model ... X-axis 5.1G, Y-axis 7.6G, two-pen model ... X-axis 4.5G, Y-axis 7.0G.

**Pen Lift:** All pens simultaneously lifted or lowered by PEN UP-DOWN switch on the front panel, or by an external contact or TTL-level signal.

**Chart Paper:** A4 size graph paper, or roll chart (optional Chart Stock required).

**Paper Holddown:** Electrostatic paper holddown with LED spot paper alignment.

**Type of Input:** Floating, guarded and shielded (polarity reversal switch on the front panel).

**Input Ranges:** 50μV/cm, 0.1, 0.25, 0.5, 1, 2.5, 5, 10, 25, 50mV/cm, 0.1, 0.25, 0.5, 1, 2.5, 5V/cm (16 calibrated ranges plus continuous vernier between ranges).

**Zero Set:** Adjustable to any point on the writing area.

**Input Impedance:** Approx. 1MΩ constant on all input ranges.

**Maximum Source Resistance:** 10kΩ.

**Zero Stability (Nominal):** ±(1.5μV+0.02% of effective recording span)/°C.

**Maximum Allowable Input Voltage (Continuous):** 50V DC on 50μV/cm to 50mV/cm ranges, or 250V DC on 0.1V/cm to 5V/cm ranges.

**Maximum Common Mode Voltage:** 250Vrms AC, or 350V DC.

**Common Mode Rejection:** More than 140dB at power line frequency or at DC.

**Normal Mode Rejection:** More than 50dB.

**Offset Input:** Selectable to ±20, ±40, ±60, ±80, ±100cm (10 ranges) or 0 (OFF) by front panel dial.

**Accuracy of Offset Input:** ±0.2% of offset setting range.

**Temperature Drift of Offset Input:** ±100ppm/°C.

**Time Base (Optional):** Sweep rates ... 0.25, 0.5, 1, 2.5, 5, 10, 25, 50 s/cm & min/cm (accuracy: ±0.5%), Pens automatically lifted after sweep or reset. Trial sweep available with pens lifted.

**Operating Position:** Horizontal, vertical or inclined.

**Operating Temperature Range:** 5 to 40°C (41 to 104°F).

**Humidity Range:** 40 to 80% relative humidity.

**Dielectric Strength:** 1,500V AC for one minute between power line and case, and between input-guard terminals and case.

**Insulation Resistance:** More than 100MΩ at 500V DC between power line and case, and between input-guard terminals and case.

**Power Requirements:** 100, 115, 200 or 230V AC (must be specified), for both 50 and 60Hz.

**Power Consumption (Approx.):**

| Model | Maximum | Balanced |
|---|---|---|
| One-pen model | 180 VA | 40 VA |
| Two-pen model | 210 VA | 50 VA |

**Dimensions:** Approx. 299 x 413 x 152 mm (11-3/4 x 16-1/4 x 6").

**Weight:** One-pen model ... approx. 13 kg (28.7 lbs), two-pen model ... approx. 14 kg (30.9 lbs).

### Accessories and Spares

| Item | | Accessories supplied at no extra cost | | Code as additional spares |
|---|---|---|---|---|
| | | One-pen model | Two-pen model | |
| A4-size sheet (Metric) | | 50 sheets | 50 sheets | **B9523VQ** 308411 (100 sheets) |
| A4-size sheet (Inch) | | — | — | **B9551AX** (100 sheets) |
| Roll chart (15m long) | | — | — | **B9523VY** 308403 (10 rolls) |
| Disposable felt-tip pen cartridge | $Y_1$ 1st pen (red) | 3 pcs. | 3 pcs. | **B9543CL** (9 pcs.) |
| | $Y_2$ 2nd pen (green) | — | 3 pcs. | **B9543CM** (9 pcs.) |
| Dust cover | | 1 pc. | 1 pc. | Order by name |
| *Rack mounting screw | | 4 pcs. | 4 pcs. | Order by name |
| Fuse | | 2 pcs. | 2 pcs. | Order by name |
| Power cord (2- or 3-prong type) | | 1 set | 1 set | Order by name |
| 24-contact connector plug for remote control | | 1 pc. | 1 pc. | **A9025KC** 309953<br>(AMPHENOL 57-30240) |

*Note: Rack adapter is not required to rack-mount Model 3025.

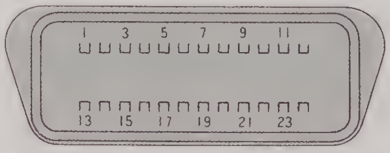
## Remote Controls by External Contact or TTL-Level Signals (Standard)

| Function | Description |
|---|---|
| **Remote pen lift control** | All pens are simultaneously lifted or lowered. |
| **Remote time base control** | Remote control of sweep start (SWEEP TRIAL or SWEEP RECORD) and reset (RESET). |
| **Remote chart drive control** | Remote control of chart drive START/STOP and chart speed (optional chart drive unit is required). |

## Remote control connector contact functions (AMPHENOL 57-40240)

| Pin No. | | Pin No. | |
|---|---|---|---|
| 1 | *Sweep Trial | 13 | **Frame |
| 2 | *Sweep Record | 14 | **EXT. Chart Speed |
| 3 | Pen Lift | 15 | Common |
| 4 | **Chart Start/Stop | 16 | — |
| 5 to 12 | — | 17 to 24 | — |

Notes: *: For the model with time base (**/TIME**).
**: Functions used with **308951**.



Rear connector

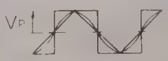
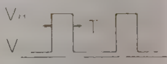
## 308951 Chart Drive Unit (Optional Accessory)

Model **3025** can be used as a pen recorder, when combined with **308951**.

**Chart Speeds:** 2, 6, 20, 60 cm/min & cm/h (accuracy …±0.25%).

**FRAME Mode:** Used to advance the chart in 300 mm steps.

**Remote Chart Drive Control:** Remote control of chart drive START/STOP and chart speed by external signal.

| Remote control signal waveforms | Sine, triangular or rectangular waveform | Pulse train |
|---|---|---|
| Signal level | <br>4V < $V_P$ < 24V | <br>+4V < $V_H$ < +24V<br>24V < $V_L$ < +0.5V<br>$T_P$ < 100μs |
| Max. signal source impedance | 600Ω | 50Ω |
| Chart speed | 0.3f cm/min, cm/h (f … Hz or PPS) | |
| Max. frequency | 200 Hz | 200 PPS |

[illegible]

| Model | Description |
|---|---|
| **302513** | One-pen model (16 ranges) |
| **302523** | Two-pen model (16 ranges) |

[illegible]

| Name | Model | Description |
|---|---|---|
| Chart drive unit | **308951** | Chart stock **(/ROL)** is always required |
| *Rack adapter | **303581** | Metric |
| | **303582** | Inch |

*Note: Rack adapter is required to rack-mount Model 3025 with 308951.

[illegible]

| Function | Suffix Codes | Description |
|---|---|---|
| Time base | **/TIME** | 0.25 to 50s/cm & min/cm |
| Chart stock | **/ROL** | Chart stock compartment and chart supply roller built into mainframe (always required for roll chart recording) |
| Writing table protection cover | **/FRT** | 1 pc. |
| Inch calibration | **/INCH** | Inch calibration for both X and Y axes |

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03

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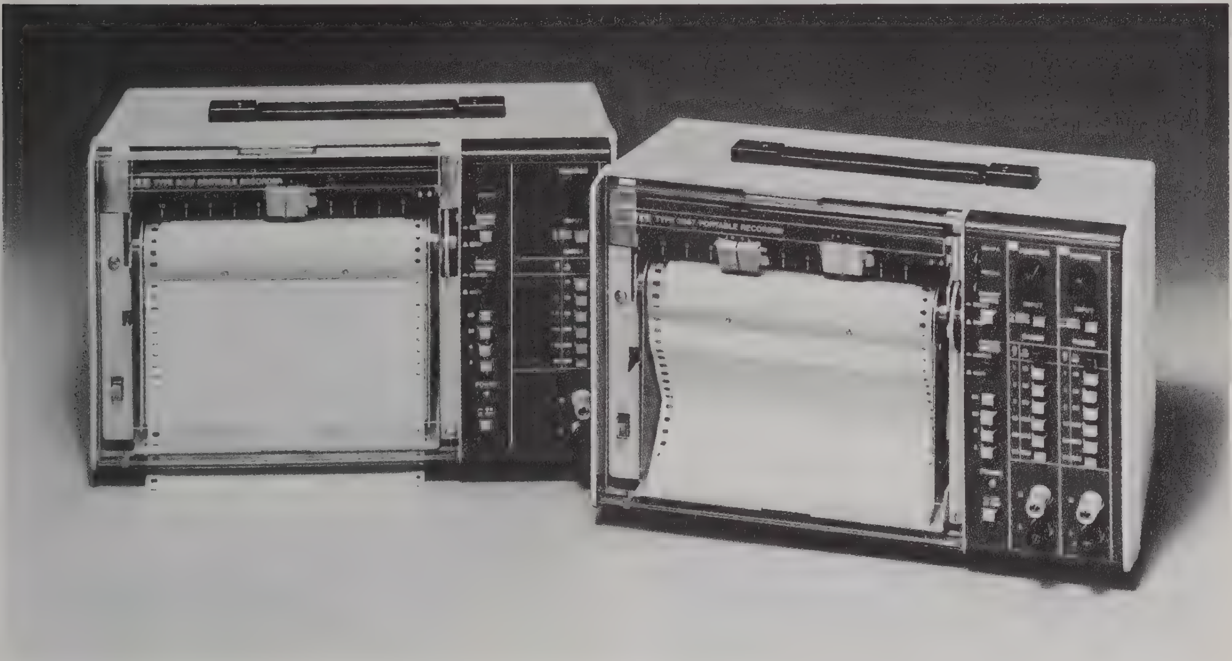
# 3057
# Portable Recorders

## Compact, Exceptionally Reliable 150mm Recorders. . . .
## Operate on External AC or DC, Internal Ni-Cd or Standard Battery



The YEW Type 3057 is a new, convenient-sized 150mm portable recorder designed for use in virtually every application, including field and laboratory work.

Within its compact, portable case, Type 3057 includes a host of significant improvements over other conventional recorders. An entirely new, advanced servo mechanism eliminates many moving parts. It uses a non-contact position transducer that operates the recording pens magnetically, and contributes to exceptionally high reliability and extended operating life. Chart drive is consistently stable using a crystal-oscillator-controlled pulse motor.

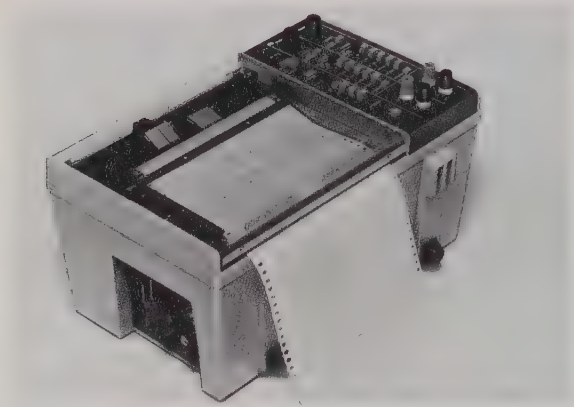
Type 3057 offers a full range of features including one or two pens, Z-fold or roll charts, and vertical or flatbed use. Moreover, a choice of power source . . . external AC or DC, internal rechargeable Ni-Cd battery or ten 1.5V batteries.

## MAIN FEATURES

- **One- or two-pen model**
- **Z-fold or roll chart recording**
- **Both vertical and flatbed operation using roll chart**
- **Three different power source models:**
  - * External AC
  - * External AC, DC and internal Ni-Cd battery
  - * External AC, DC and internal common ten 1.5V batteries
- **Exceptionally high reliability and trouble-free operation thru use of YEW-original ultrasonic pen position transducer — eliminates balancing slidewire**
- **12 calibrated input ranges from 10mV to 50V full scale**
- **8 pushbutton-selected chart speeds — 60 cm/min to 2 cm/h**
- **Reliable, accurate chart drive using pulse motor and crystal oscillator — chart speed accuracy ±0.25%**
- **Fast response — 300mm/s max.**
- **Tilting chart plate for hand-written notes on chart**
- **Easy-to-operate, front panel pushbuttons**
- **Compact size: 223(H) x 332(W) x 174(D)mm, lightweight: only 5 kg**
- **Optional remote controls**

## CONVENIENT FEATURES

### ■ VERTICAL OR FLATBED USE



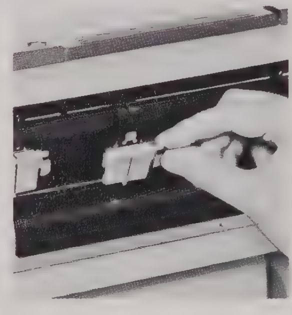
Using a roll chart, Type 3057 operates in either vertical or horizontal position. Accordingly, Type 3057 is usable as a bench-top recorder, or for field applications.

### ■ Z-FOLD OR ROLL CHART RECORDING

Z-fold or roll chart recording can be selected simply by adjusting the position of four screws inside the chart magazine.

### ■ MESS-FREE, DISPOSABLE FELT-TIP PEN RECORDING

Disposable snap-in felt-tip pen cartridges can be replaced in seconds.
Line quality is excellent with clear red or green lines.



### ■ OPERATION FROM EXTERNAL AC, DC, INTERNAL Ni-Cd OR COMMON 1.5V BATTERIES

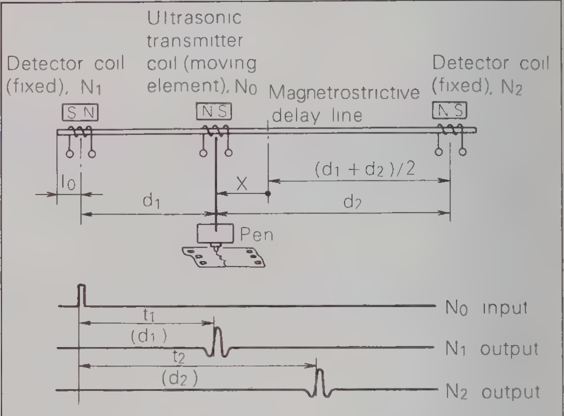
Select the power input you need — AC line, external 12V DC, internal rechargeable Ni-Cd battery, or ten internal 1.5V batteries.

*Ni-Cd battery installed*

### ■ VERSATILE REMOTE CONTROL OPTION

Remote control option determines chart speed with external rectangular or pulse waves, and controls chart start/stop with contact or TTL-level signals.

### ■ NON-CONTACTING ULTRASONIC PEN POSITION TRANSDUCER ENSURES LONGER OPERATING LIFE AND HIGHEST RELIABILITY

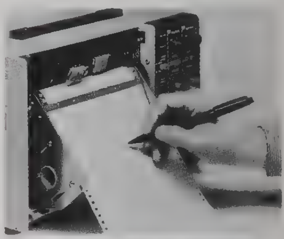

Ultrasonic transmitter coil (moving element), N0
Detector coil (fixed), N1
Magnetrostrictive delay line
Detector coil (fixed), N2
S N
N S
N S
l0
X
d1
(d1 + d2)/2
d2
Pen
N0 input
t1
(d1)
N1 output
t2
(d2)
N2 output

*Non-contacting ultrasonic pen position transducer*

The heart of Type 3057 is the YEW-original, non-contacting ultrasonic pen position transducer used in the servo mechanism. This new system eliminates many moving parts, which result in higher reliability and longer operating life than conventional potentiometers.

### ■ TILTING CHART PLATE

The writing/viewing table can be slanted for quick data review, and for convenient note-taking on a flatbed table.



## TYPES AVAILABLE

| Type number | Basic code | Option code | Description |
|---|---|---|---|
| **3057** | | | Portable recorder |
| | | | Number of pens |
| | **1** | | 1 |
| | **2** | | 2 |
| | | | Power requirements |
| | **1** | | AC line . . . 100, 115, 200, 220 or 230V AC (must be specified), 50 and 60Hz |
| | **2** | | AC line, internal rechargeable Ni-Cd battery, and external 12V DC |
| | **3** | | AC line, internal ten 1.5V batteries, and external 12V DC |
| | | | Optional feature |
| | | **/CHC** | Remote chart drive control (Refer to back page) |

Example: 305721/CHC . . . 2-pen, AC line operation model with remote chart drive control option.

## SPECIFICATIONS

**Drive System:** Automatic null-balancing DC servo mechanism using non-contacting ultrasonic pen position transducer.

**Number of Pens:** 1 or 2 (pen distance . . . approx. 5mm on the time axis).

**Writing System:** Ink writing using disposable felt-tip pen cartridges.

**Ink Colors:** Red for 1st pen, green for 2nd pen.

**Effective Recording Span:** 150mm.

**Accuracy:** ±0.5% of effective recording span (includes non-linearity and deadband) at an ambient temperature of 23±5°C on 500mV range.

**Deadband:** Less than 0.2% of effective recording span.

**Maximum Pen Speed (Nominal):** 300mm/second.

**Chart:** Z-fold chart (174mm x 15m), or roll chart (174mm x 20m), with calibrated width of 150mm (100 uniform divisions at 1.5mm/division), 5mm uniform divisions on time axis.

**Chart Drive:** Pulse motor drive using crystal oscillator.

**Chart Speeds:** 2, 6, 20, 60 cm/min and cm/h (chart speeds accuracy . . . ±0.25%).

**Type of Input:** Floating.

**Voltage Ranges:** 10, 20, 50, 100, 200, 500mV, 1, 2, 5, 10, 20, 50V full scale (12 calibrated ranges).

**Zero Set:** Adjustable for each pen over full effective recording span.

**Input Resistance:** Approx. 1MΩ constant on all voltage ranges.

**Maximum Allowable Source Resistance:** 10kΩ.

**Maximum Allowable Input Voltage (Continuous):** 50V DC on 10 to 500mV ranges, 250V DC on 1 to 50V ranges.

**Maximum Common Mode Voltage:** 130Vrms (sine wave), 180V DC.

**Common Mode Rejection:** More than 130dB at power line frequency, or at DC.

**Normal Mode Rejection:** More than 50dB at power line frequency.

**Pen Lift:** Mechanical for both pens.

**Operating Position:** Vertical or horizontal (vertical only for Z-fold chart).

**Warm-up Time:** Approx. 15 minutes.

**Operating Temperature Range:** 0 to 50°C (32 to 122°F).

**Humidity Range:** 40 to 80% relative humidity.

**Dielectric Strength:** 1,500V AC for one minute between power line and case, 1,000V AC for one minute between input terminals and case.

**Insulation Resistance:** More than 100MΩ at 500V DC between power line and case, and between input terminals and case.

**Power Requirements:** **3057☐1** . . . external AC; 100V (90 to 110V), 115V (100 to 130V), 200V (180 to 220V), or 230V (200 to 250V) AC (must be specified), 50 and 60Hz,

**3057☐2** . . . external AC (specify voltage), internal rechargeable Ni-Cd battery (installed, continuously operates about 10 hours on a single charge for one-pen model), and external 12V DC,

**3057☐3** . . . external AC (specify voltage), internal ten 1.5V batteries (supplied in an accessory box), and external 12V DC.

**Power Consumption (Approx):**

| Model | Maximum | Balanced |
|---|---|---|
| 1-pen model | 16VA | 13VA |
| 2-pen model | 22VA | 16VA |

**Dimensions:** Approx. 223 x 332 x 174mm (8-3/4 x 13-1/8 x 6-7/8").

**Weight (Approx):** **305711** . . . 5kg (11.0 lbs), **305721** . . . 6kg (13.2 lbs), **305712** or **305713** . . . 7kg (15.4 lbs), **305722** or **305723** . . . 8kg (17.6 lbs).

## ACCESSORIES AND SPARES

| Item | | Accessories supplied at no extra cost | | | | | | To order additional spares, specify code |
|---|---|---|---|---|---|---|---|---|
| | | **305711** | **305712** | **305713** | **305721** | **305722** | **305723** | |
| Recording paper | Z-fold chart (174mm x 15m) | 1 | 1 | 1 | 1 | 1 | 1 | **B9529AA** 304513 (box of 10 charts) |
| | Roll chart (174mm x 20m) | – | – | – | – | – | – | **B9529AB** 304514 (10 rolls) |
| Disposable felt-tip pen cartridge | 1st pen (red) | 3 | 3 | 3 | 3 | 3 | 3 | **B9518CT** 306961 (9 pcs) |
| | 2nd pen (green) | – | – | – | 3 | 3 | 3 | **B9518CU** 306962 (9 pcs) |
| Rechargeable Ni-Cd battery (built-in) | | – | 1 | – | – | 1 | – | **A9002ED** 289904 |
| 1.5V batteries (JIS C 8501 SUM-1D) | | – | – | 10 | – | – | 10 | Order by name |
| External DC power source connector | | – | 1 | 1 | – | 1 | 1 | Order by name |
| Lubricant (2 cc) | | 1 | 1 | 1 | 1 | 1 | 1 | Order by name |
| Fuse | 0.2 or 0.1A (for AC line operation) | 1 | 1 | 1 | 1 | 1 | 1 | Order by name |
| | 2A (for Ni-Cd or ext. DC operation) | – | 1 | 1 | – | 1 | 1 | Order by name |
| Power cord (2- or 3-prong type) with cord binding belt | | 1 | 1 | 1 | 1 | 1 | 1 | Order by name |
| Extra 14-contact connector plug for remote control option | | – | – | – | – | – | – | **A9024KC** 309977 |

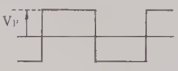
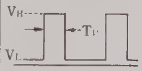
Notes: 1. Codes B9518CT (306961) and B9518CU (306962) are also usable for the following YEW recorders: Types 3033, 3036, 3056, 3066 and 3086.

2. One Code A9024KC (309977) connector plug is supplied with a remote control option.

## OPTIONAL FEATURES

### Remote chart drive control (Option code . . . /CHC)

- Remote control of chart speed by external rectangular waves or pulse train.

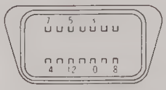
| Remote control signal waveforms | Rectangular waves | Pulse train |
|---|---|---|
| Signal level |  <br>$4V<V_P<24V$ |  <br>$+4V<V_H<+24V$<br>$-24V\leq V_L<+0.5V$<br>$T_P>1ms$ |
| Max. signal source impedance | 600 Ω | 50 Ω |
| Chart speed | 0.3f cm/min (f . . . Hz or PPS) | |
| Max. frequency | 200Hz | 200 PPS |

- Remote control of chart drive START/STOP by external TTL-level, open collector or contact signal:

L logic level or closed contact . . . CHART DRIVE START.
H logic level or open contact . . . CHART DRIVE STOP.

TTL or open collector remote control signal levels:
H . . . +2.4 to +5V, L . . . 0 to +0.5V.

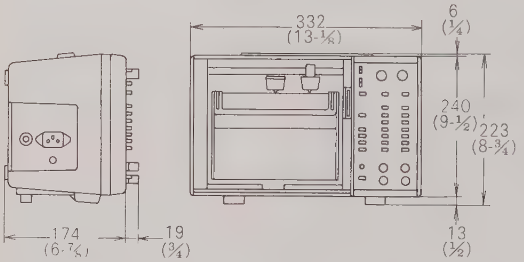
**Remote control connector contact functions**



| Pin No. | | Pin No. | |
|---|---|---|---|
| 1 | – | 8 | Pins 8 to 13 internally connected (signal common to Pins 1 to 7) |
| 2 | – | 9 | |
| 3 | – | 10 | |
| 4 | Ext. Start/Stop | 11 | |
| 5 | | 12 | |
| 6 | Ext. Clock In | 13 | |
| 7 | Clock Select | 14 | Case |

## DIMENSIONS

Unit: mm (approx. inch)



**Ordering Information**

When ordering or requesting quotations, specify:

1. Instrument name and basic code.
2. Code of optional feature (option code), if desired.
3. Power supply voltage and power cord type (2- or 3-prong).
4. Spare item(s) and quantity required.

YOKOGAWA ◆

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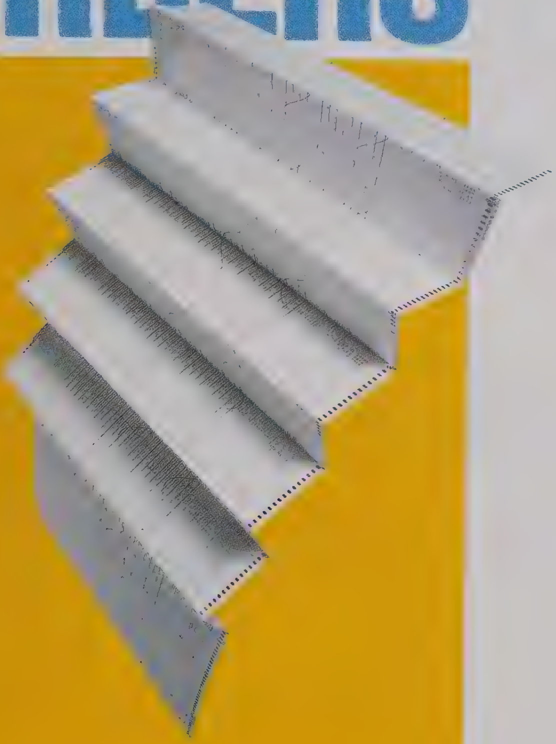
# RECORDERS



## A Complete Lineup of Laboratory Recorders

LR8100
LR4100
LR4200
HR2300
HR1300
3057
3021
3022
3023
3024
3025
3036

YOKOGAWA

Bulletin 3700-U

# Intelligent Pen Recorders.

## LR8100

High accuracy and response make this superb instrument a worldwide bestseller. Its computer-based functions bring a new concept to pen recording.

| | |
|---|---|
| Chart width/length | : 250 mm/30 m |
| Sampling rate | : 135 Hz |
| Pen response | : 1,600 mm/s |
| Writing method | : Pen—8 colors |
| Channels | : 4, 6, or 8 |
| Input type | : Freely programmable<br>DC V (0.1 mV—200 V),<br>12 TC's, & 4 RTD's |
| Communication | : RS-232-C, GPIB |
| Special Features | : IC Memory Card, DC power supply |

## LR4100

This portable 4 pen recorder is perfect for field use as well as in the lab. It, like other LR recorders, includes an IC Memory Card to store setting and measurement data.

| | |
|---|---|
| Chart width/length | : 250 mm/20 m |
| Sampling rate | : 135 Hz |
| Pen response | : 1,600 mm/s |
| Writing method | : Pen—4 colors |
| Channels | : 1, 2, 3, or 4 |
| Input type | : Freely programmable<br>DC V (0.1 mV—200 V),<br>12 TC's, & 4 RTD's |
| Communication | : RS-232-C, GPIB |
| Special Features | : IC Memory Card, DC power supply |

## LR4200

Designed for all who prefer a flatbed type; providing improved visibility and notation possibilities. Both Z-fold and roll chart models, with reroll functions, are available.

| | |
|---|---|
| Chart width/length | : 250 mm/20 m |
| Sampling rate | : 135 Hz |
| Pen response | : 1,600 mm/s |
| Writing method | : Pen—4 colors |
| Channels | : 1, 2, 3, or 4 |
| Input type | : Freely programmable<br>DC V (0.1 mV—200 V),<br>12 TC's, & 4 RTD's |
| Communication | : RS-232-C, GPIB |
| Special Features | : IC Memory Card |

# Proven Reliability-Strip Chart & X-Y Recorders

## 3057

### Portable Recoder

Operating on external AC, DC or internal Ni-Cd or standard batteries and weighing less than 5 kg (11 lbs), this may be the ultimate in portable pen recorders.

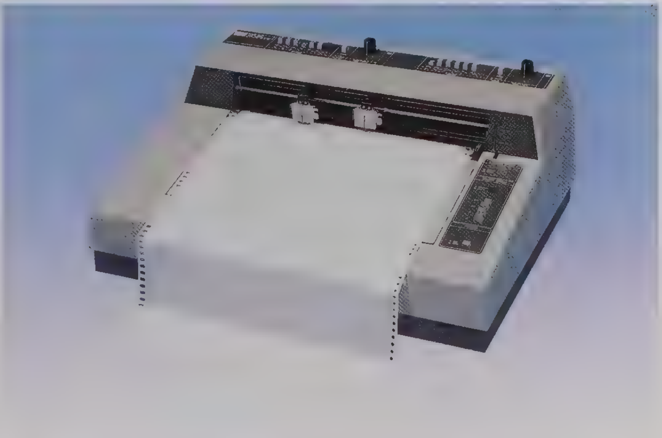
Chart width/length : 150 mm/15 m
Pen response : 300 mm/s
Writing method : Felt pen—2 colors
Channels : 1 or 2
Input ranges : DC V (10 mV—50 V)
Special Features : Lightweight, DC & battery power

## 3021

### Flatbed Pen Recoder

A low cost, highly reliable strip chart recorder perfect for OEM. Easy to operate and maintain—uses disposable felt pens and either Z-fold or roll chart.

Chart width/length : 250 mm/20 m
Pen response : 500 mm/s
Writing method : Felt pen—2 colors
Channels : 1 or 2
Input ranges : DC V (10 mV—50 V)
Special Features : Inexpensive, DC servo drive system for reliability



## 3022

### A4 X-Y Recoder

Both A4 size and 8 1/2 × 11 inch paper can be used in this low cost X-Y recorder. Like model 3021, a no contact pen position detector and brushless DC servomotor are used for higher reliability.

Paper size : A4 and 8 1/2 × 11 inch
Pen response : X-axis 300 mm/s, Y-axis 500 mm/s
Writing method : Felt pen cartridge
Channels : 1
Input ranges : 0.5 m/cm to 2.5 V/cm
Special Features : Inexpensive, DC servo drive system for reliability

# Selection Guide

## Strip Chart Recorders

| Model | | LR8100 | LR4100 | LR4200 | 3021 | 3057 | HR1300 | HR2300 |
|---|---|---|---|---|---|---|---|---|
| Type | | Intelligent Pen Recorder | | | Pen Recorder | | Multi Point Recorder (wire dot) | |
| Recording Width | | 250mm | | | 250mm | 150mm | 150mm | 250mm |
| Maximum Inputs | | 8 | 4 | | 2 | 2 | 20 | 30 |
| Input Type | | DC V : 100$\mu$V～200V<br>TC : R, S, B, K, E, J, T, N, W, L, U, KPvsAu7Fe<br>RTD : Pt100, Pt50, Ni100, J263＊B, JPt100 | | | DC V : 10mV～50V<br>(12 calibrated ranges available) | | DC V : 20mV～50V<br>TC : R, S, B, K, E, J, T, L, U, N, W, KPvs Au7Fe<br>RTD : Cu10, Pt100, JPt100, Contact Status | |
| Sampling Rate | | 135 Hz | | | Continuous | | 20CH/2s | 30CH/s |
| Pen Speed/Recording Rate | | 1600mm/s | | | 500mm/s | 300mm/s | 50CH/2s | 60CH/2s |
| Recording | Analog & Digital | ✓ | | | — | — | ✓ | |
| | Scale Printout | ✓ | | | — | — | ✓ | |
| | Alarm | ✓ | | | — | — | ✓ | |
| | Zone | ✓ | | | — | — | ✓ | |
| | Partially Expanded | ✓ | | | — | — | ✓ | |
| | Auto Span Shift | ✓ | | | — | — | ✓ | ✓ |
| | Pen Offset Compensation | ✓ | | | — | — | NA | NA |
| Math | Linear Scaling | ✓ | | | — | | ✓ | |
| | ΔT | ✓ | | | | — | ✓ | |
| | +, −, ×, ÷ | ✓ | | | | — | ✓ | |
| | Advanced | — | | | — | — | ✓ | |
| Communication | GPIB | ✓ | | | | | ✓ | |
| | RS-232-C | ✓ | | | | — | ✓ | |
| | IC Memory Card | ✓ | | | — | — | ✓ | |

## X-Y Recorders

| Model | | 3023,3024 | 3025 | 3022 | 3036 |
|---|---|---|---|---|---|
| Writing area | | A3 size (381×254mm) | A4 size (254×180mm) | A4 size (250×180mm) | (250×250mm) |
| No. of pens | | 1, 2 | 1, 2 | 1 | 1, 2 |
| Input ranges | | 50$\mu$V to 5V/cm | 50$\mu$V to 5V/cm | 0.5mV to 2.5V/cm | 5$\mu$V to 5V/cm |
| Accuracy | | ±0.2% | ±0.25% | ±0.25% | ±0.25% |
| Input impedance | | 1 MΩ | 1 MΩ | 1 MΩ | 1 MΩ |
| Slewing speed | X | 2,000mm/s | 2,000mm/s | 300mm/s | 500mm/s |
| | Y | 2,200mm/s | 2,200mm/s | 500mm/s | 500mm/s |
| Paper holddown | | Electrostatic | Electrostatic | Mechanical | Electrostatic |
| Time base | | 0.25 to 50 s/cm & min/cm | 0.25 to 50 s/cm & min/cm | 0.25 to 10s/cm & min/cm | 0.25 to 10s/cm |
| Chart drive unit (optional) | | ✓ | ✓ | — | ✓ |

YOKOGAWA

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Telefax: 404-251-2088

Represented by:

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YOKOGAWA

# *SIMPLICITY IN MEASUREMENT*

## ◆OR2300◆

# THERMAL ARRAY OSCILLOGRAPHIC RECORDER

Bulletin 7801-01E

# SET UP, MEASURE & EVALUATE WITH LESS EFFORT, MORE ACCURACY.

The amazing OR2300 begins a new generation of thermal array recorders with no-wait, high-definition recording. With it, you can extend real-time frequency response into regions previously covered only by light beam oscillographs. In fact, the new OR2300 is so revolutionary, it may change your thinking about recorders and their use forever.

## REAL TIME CONVENIENCE

Now you can record your high-speed signals with excellent definition as they happen – in real time. It's no longer necessary to use a time-consuming and tedious two-step memory approach. With the advanced user interface, you can record fast-changing events easier than ever before possible.

## INCREASED PRODUCTIVITY

Since the OR2300 is so easy to use, you will get the measurement answers you want, the first time you use it. Its innovative user interface incorporates an intuitive menu system, Soft Keys, an EL display, rotary knobs, and PC keyboard. These features help you achieve fast, accurate instrument setup for even the most complex measurement applications.

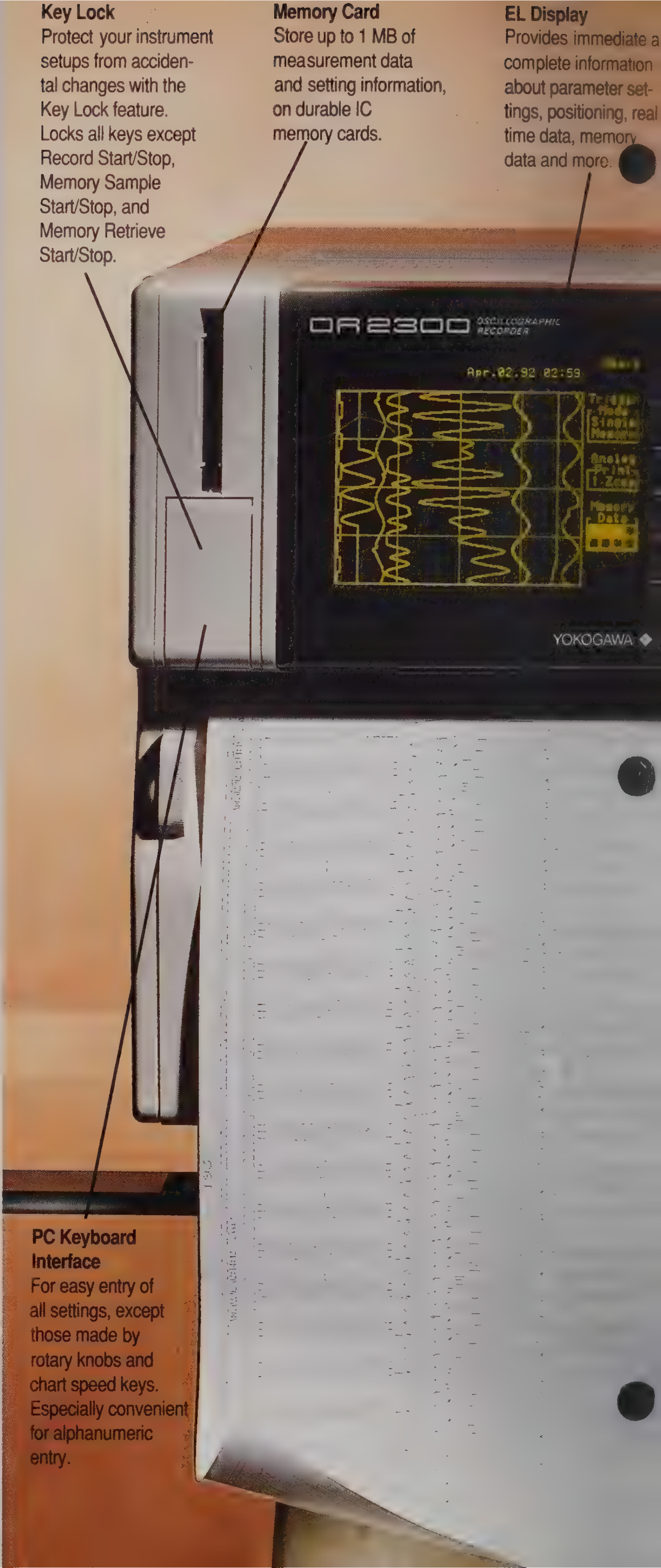
The result? Reduced operator error and increased productivity. With the OR2300, recording fast-changing data has never been easier.

## ACCURATE EVALUATIONS

Recording is only part of the job. The enhanced recording formats of the OR2300 identify the exact information you're looking for instantly, so you'll get immediate answers to your measurement questions.

The OR2300 also saves you time in evaluating test results by providing linearized temperature recordings, two levels of trace intensity, flexible zone recording, and complete annotation of recorded data.

In every way, the OR2300 is designed to help you get the job done quicker and more efficiently. Whatever you do – setup, measurement, and evaluation – is easier with the OR2300. Your only difficulty would be surviving without it.



**Key Lock**
Protect your instrument setups from accidental changes with the Key Lock feature. Locks all keys except Record Start/Stop, Memory Sample Start/Stop, and Memory Retrieve Start/Stop.

**Memory Card**
Store up to 1 MB of measurement data and setting information, on durable IC memory cards.

**EL Display**
Provides immediate a
complete information about parameter settings, positioning, real time data, memory data and more.

**PC Keyboard Interface**
For easy entry of all settings, except those made by rotary knobs and chart speed keys. Especially convenient for alphanumeric entry.

**Soft Keys**
Select menu items shown on the EL display quickly using Yokogawa's Soft Keys.

**Trigger/Memory**
Trigger on complex conditions using the OR2300's advanced capabilities. You can capture memory data either with the chart recording OFF or ON.

**Rotary Knobs**
Fast and convenient to use when making adjustments similar to analog recorders.

## THE OR2300 OFFERS CLEAR ADVANTAGES:

- High quality real time recording
- Intuitive operation guarantees ease of use
- Flexible and portable benchtop design weighs less than 18 Kg/40 lbs.

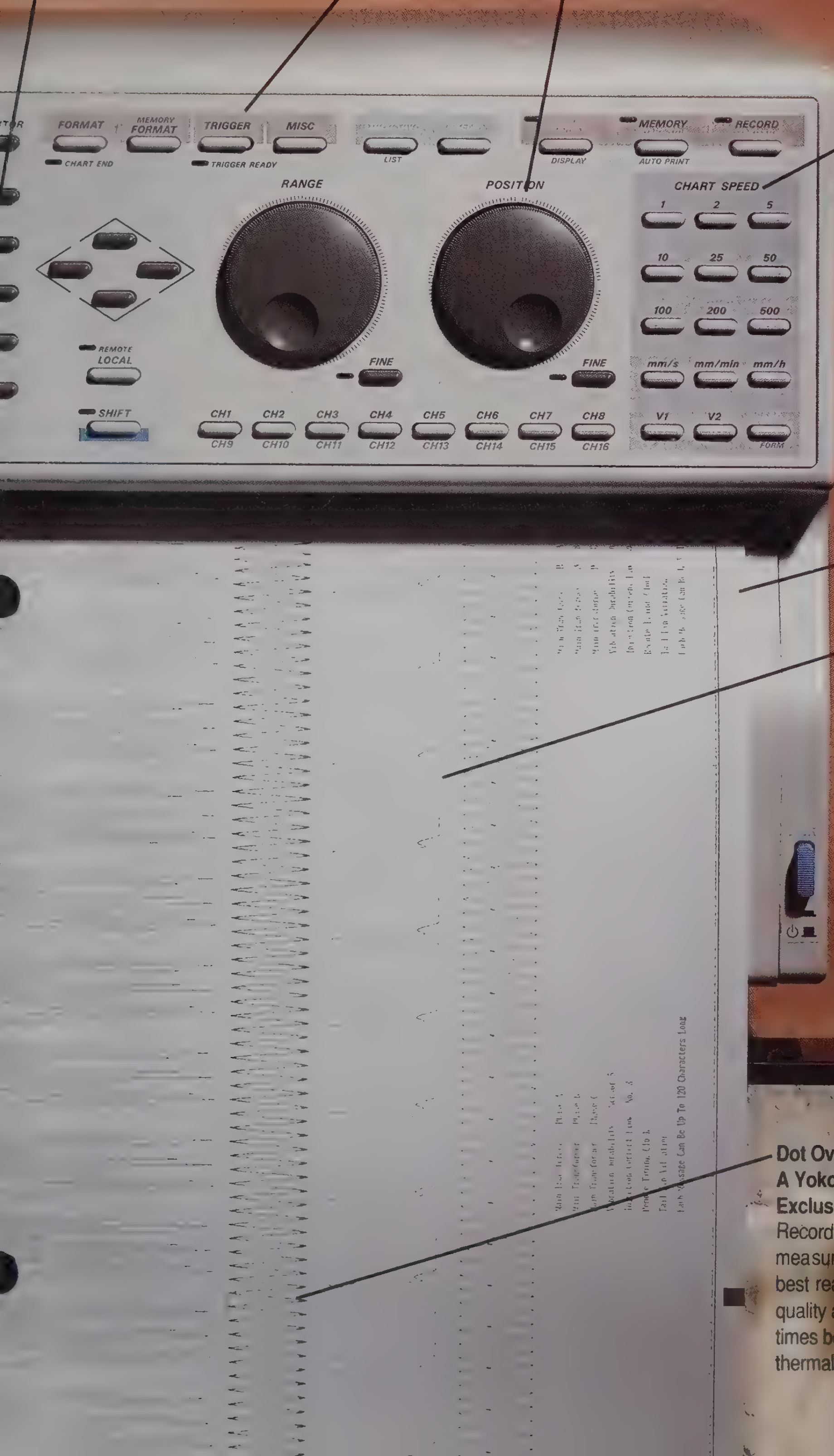


**Chart Speed Keypad**
**500 mm/s maximum**
Fast chart speed for time axis details. Two variable speeds provide quick access to custom chart speeds. Use this keypad to enter alphanumerics from front panel.

**Wide Chart**
Expands your signal to show all the detail you need.

**Thermocouple Inputs**
Measure and record temperature directly using 6 popular thermocouples.

**Dot Overlap**
**A Yokogawa Exclusive!**
Record details of your measurements with the best real time recording quality available. FOUR times better than other thermal array recorders.

# THREE MEASURES OF EXTRAORDINARY SIMPLICITY

## THE QUICKEST AND CLEAREST RECORDING EVER

The OR2300 records faster signals continuously in real time – quickly, easily, and with the best recording quality available.

Yokogawa's exclusive "Dot Overlap" technology lets you record faster signals in real time with perfect clarity. At the fastest chart speeds of 500 mm/s, the OR2300 still exceeds the printed resolution of a laser printer.

Compare it to conventional recording and you'll see the distinct difference and remarkable improvement. And, with "Dot Overlap" you can record your signals directly to chart paper and skip the memory step completely! "Dot Overlap" enables you to achieve higher productivity and solve problems more quickly. See page 9 for details on this breakthrough technology.

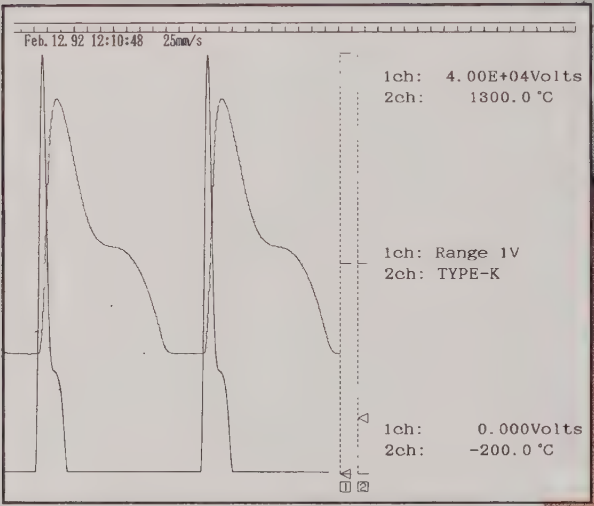
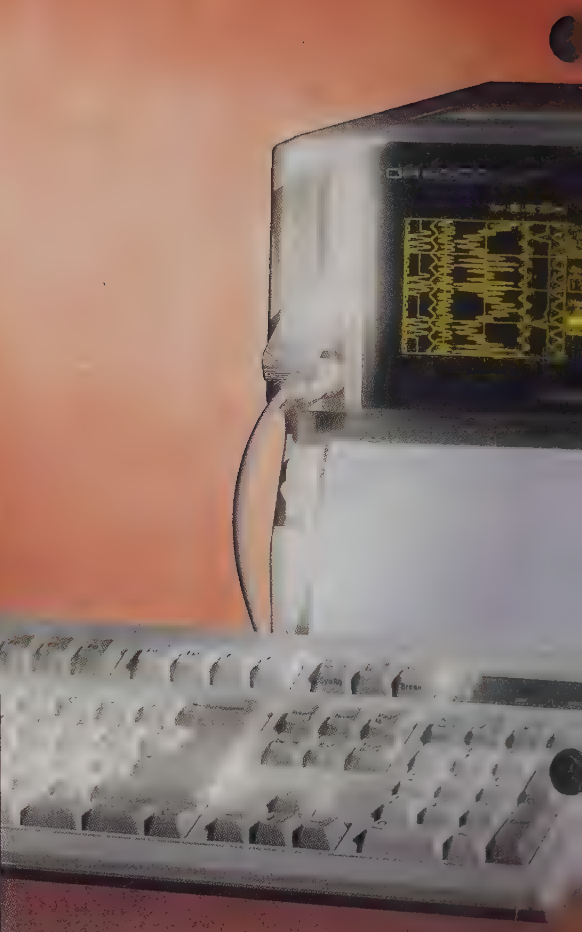


*Chart recordings are easier to read using direct thermocouple input, linear scaling and 2 levels of trace intensity.*



## ENHANCED RECORDING FORMATS FOR INFORMATION AT A GLANCE

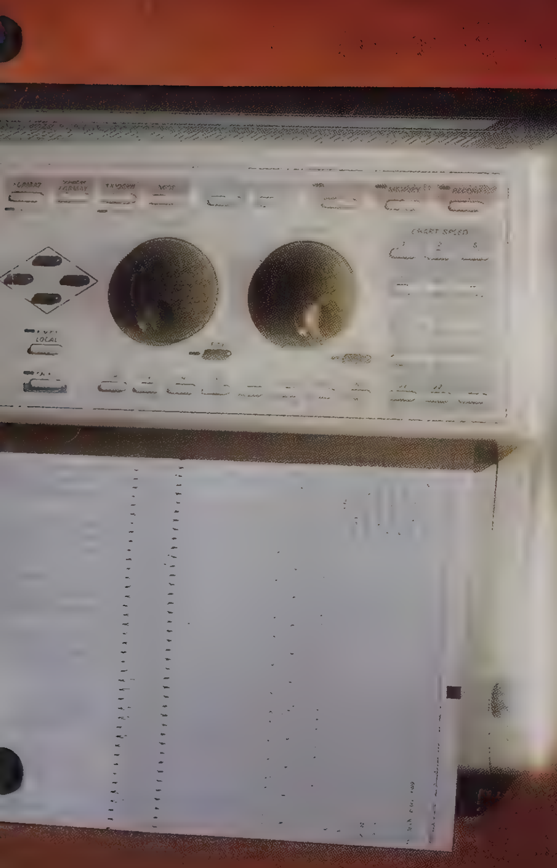
The OR2300's thermocouple inputs provide linear temperature recording in °C or °F. No more guess work or approximations – you'll get accurate temperature information directly. This feature is available on all models with isolated inputs.

Linear Scaling helps you interpret data more quickly and more accurately by converting obscure voltage measurements to values of the corresponding physical properties they represent. Two levels of Trace Intensity let you easily discern between overlapping channels.

Use Flexible Zone Recording to maximize recording positioning and zone sizing – and put each channel's trace anywhere on the paper you like. You can group channels together, or separate them; you can record key channels in large zones for detailed resolution, and supporting channels in smaller zones.

Flexible Zone Recording also simplifies evaluation of memory data by giving you control of the recorded format when data is played back from memory and recorded.

Plus, the OR2300 eliminates expensive chart paper waste caused by time consuming trial runs that conventional recorders require to adjust recording positions. By using the large rotary knobs you can adjust zero offset and full scale positions while you view the changes on screen – and you know exactly where your signals will be recorded.



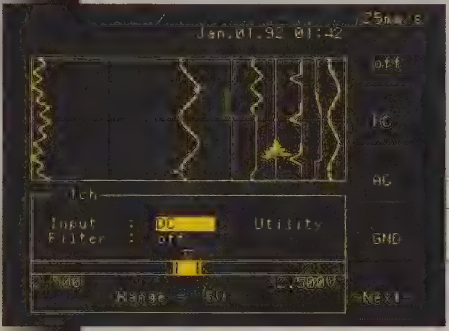
*Maximum recording detail for key channels is obtained with Flexible Zone Recording, allowing simple placement of analog traces anywhere, any size.*

With messages, titles, headers, event markers, time stamps, channel identifiers, and other annotations, you have a complete recording solution.

## EASY-TO-USE, INFORMATIVE USER INTERFACE

Fine tuning your recorder's configuration has never been easier. The OR2300 simplifies the setup procedure and reduces operator error. This unique user interface is so intuitive and complete that you will save time, every time.

Pressing a single key displays the available input types, current settings, and the actual waveform being measured. To make selections, just press a Soft Key or rotate a knob. The displayed waveform immediately shows any changes.

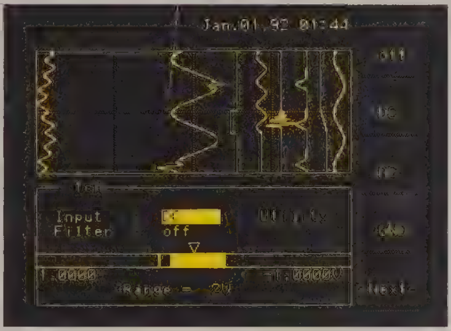

Jan.01.92 01:42
1ch
Input : DC
Filter : off
Range = 5V

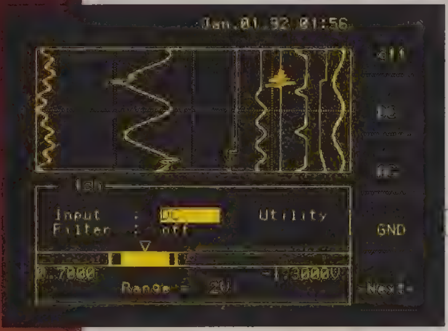
**STEP 1**

*Easily select AC, DC, thermocouple or zero position setting using Soft Keys at right of EL Display.*

**STEP 2**

*Quickly select input levels with the Range Rotary Knob. Changes are seen on the displayed waveform, while the highlight bar indicates input level.*


Jan.01.92 01:44
1ch
Input DC
Filter off
Range = 2V

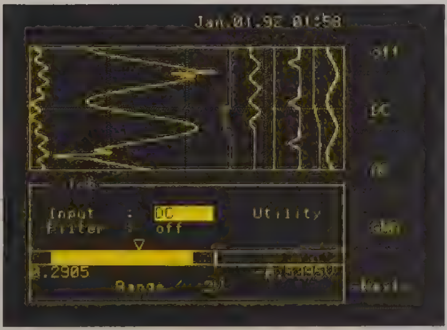

Jan.01.92 01:56
1ch
Input : DC
Filter : off
Range = 2V

**STEP 3**

*Move the waveform with the Position Rotary Knob.*

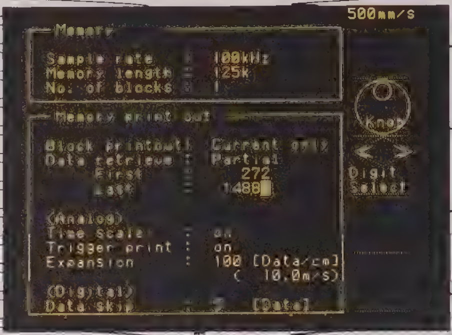
**STEP 4**

*Zoom in on selected Range by adjusting the Recording span to fill recording area with desired signal.*


Jan.01.92 01:58
1ch
Input : DC
Filter : off
Range = 2V

# RECORDING FLEXIBILITY ENSURES ACCURATE ANALYSIS

*Detailed analysis is possible with high speed memory capture and flexible retrieval capabilities.*


500mm/s

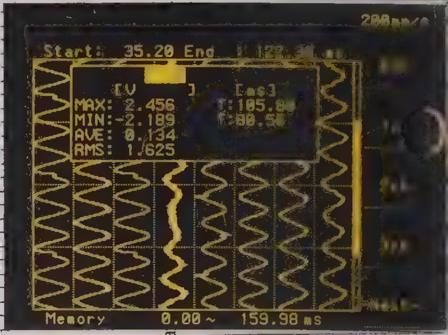
Memory

```
Sample rate    :  100kHz
Memory length  :  125k
No. of blocks  :  1
```

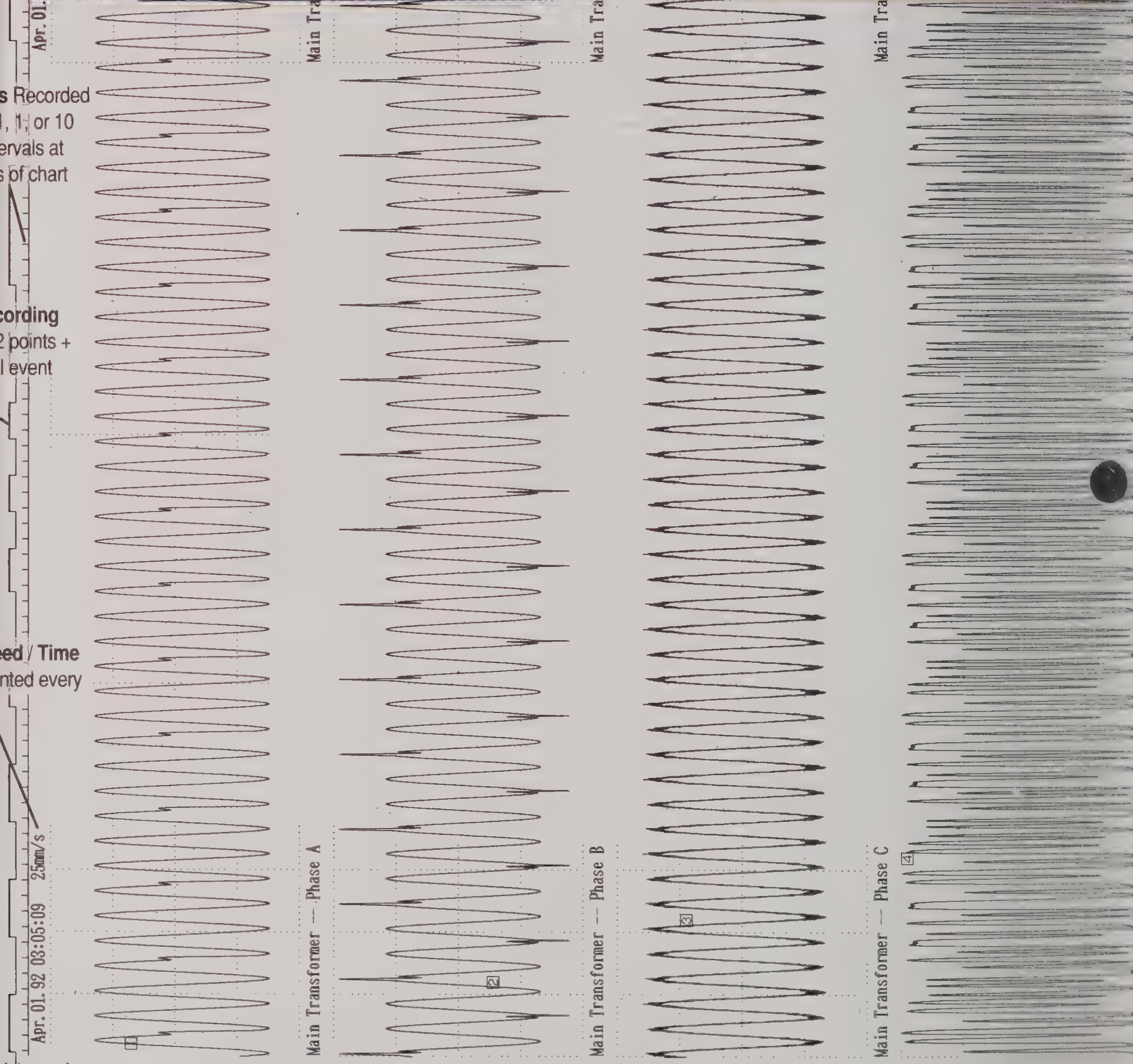
Memory print out

```
Block printout :  Current only
Data retrieve  :  Partial
      First    :     272
      Last     :    1488

(Analog)
Time scale     :  on
Trigger print  :  on
Expansion      :  100 [Data/cm]
                  (  10.0m/s)

(Digital)
Data skip      :  5    [Data]
```

*Statistical calculations provide immediate insight to data values. The highlight bar indicates selected portion of memory.*


200mm/s

```
Start:  35.20 End  : [illegible] ms
   [V        ]   [ms]
MAX:  2.456     T:105.80
MIN:-2.189      f:80.50
AVE:  0.134
RMS:  1.625
Memory      0.00 ~   159.98 ms
```



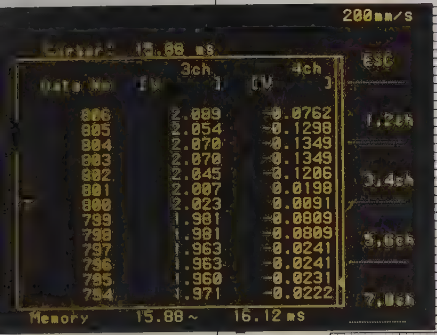
**Time Ticks** Recorded at 0.01, 0.1, 1, or 10 second intervals at both edges of chart

**Event Recording** Standard 2 points + 16 optional event inputs

**Chart Speed / Time Stamp** Printed every 160 mm

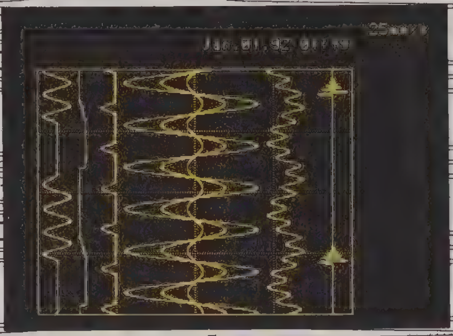
**Logging** Values of all channels printed digitally across single line. Recording interval: 1, 2, 5, 10, 20, 30, or 60 sec selectable

```
This Header can be used to document details of your tests. It accepts 5 lines
You input the text for these lines using the IBM keyboard or directly from the
Sam Simione and Russ Davis ran this test for Brian Blanchette and Keith Scot
Tests were ran on prototype 17 in Building 4.
The purpose of these tests is to evaluate the prototype ignition and timing
 01:58:27     107.1     0.7000      0.691    -0.5437     -1.658     0.1120      2.1
 01:58:26      66.9      1.166      0.441     0.6277     -1.609     0.1148      2.2
 01:58:25      20.1      2.695      0.184     0.6303     -1.569     0.1146      0.0
   Time      [mV    ]  [kg/cm2]  [V      ]  [mm     ]  [V      ]  [mm/kg ]  [V
Apr.01.92     1ch        2ch        3ch        4ch        5ch        6ch        7ch
```

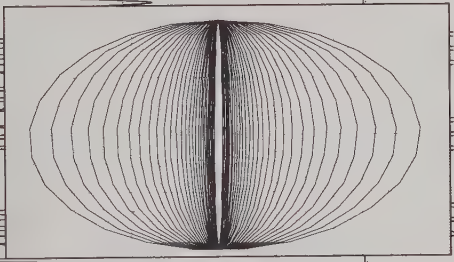


```
                                          200mm/s
   Cursor: 15.88 ms
                      3ch          4ch           ESC
   Data No     [V       ]   [V       ]
        806      2.089      -0.0762              1,2ch
        805      2.054      -0.1298
        804      2.070      -0.1349
        803      2.070      -0.1349
        802      2.045      -0.1206              3,4ch
        801      2.007       0.0198
        800      2.023       0.0091
        799      1.981      -0.0809
        798      1.981      -0.0809              5,6ch
        797      1.963      -0.0241
        796      1.963      -0.0241
        795      1.960      -0.0231
        794      1.971      -0.0222              7,8ch
   Memory      15.88 ~     16.12 ms
```

*Examine precisely both pre- and post- trigger data on the EL display. The 'T' shows the trigger point.*



*You can monitor your data using a variety of EL display modes, including Full Overlap and digital displays.*

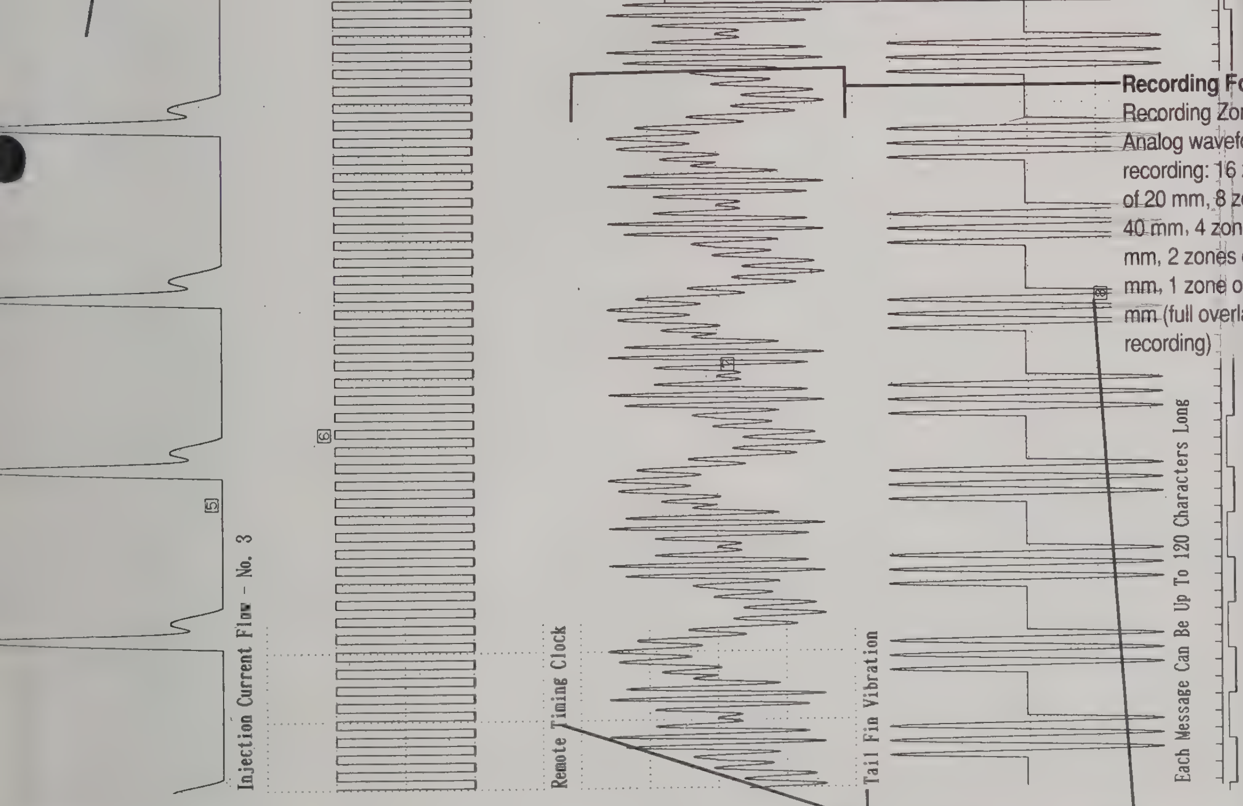


**X-Y Mode**

*Select any channel for the X-axis and any other four channels for the Y-axis.*

**Grids** 10 mm div. with or without fine gridlines, and 10 equal divisions with or without fine gridlines

**Recording Formats**
Recording Zone:
Analog waveform recording: 16 zones of 20 mm, 8 zones of 40 mm, 4 zones of 80 mm, 2 zones of 160 mm, 1 zone of 320 mm (full overlap recording)



characters
panel keys. For example -
ineering Group III.

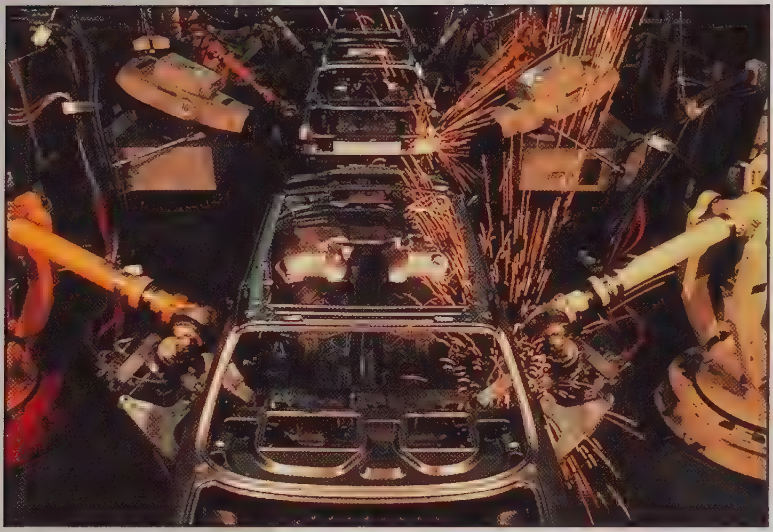
-2.198
-2.192
-2.178
]
8ch

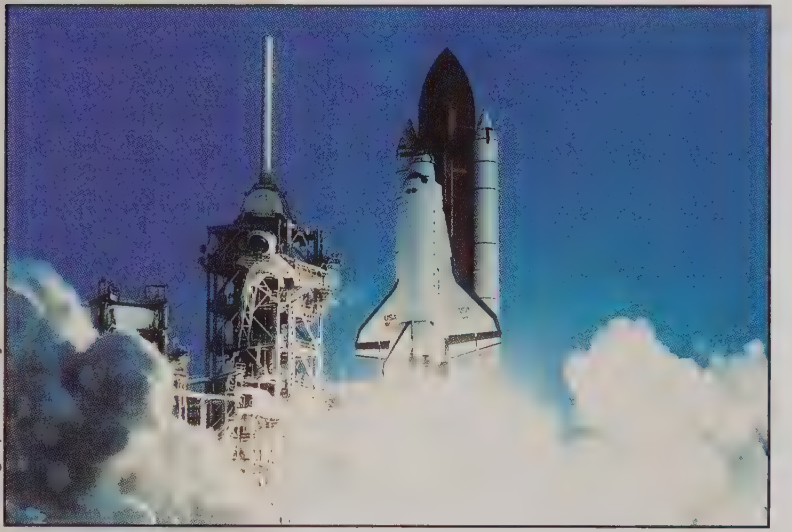
**Header** 136 characters x 5 lines

**Message** 120 characters/ channel, recorded every 160 mm

**Channel ID** Printed every 800 mm (at chart speeds up to 100 mm/s)

**Effective Recording width** 370 mm (320 mm for waveform recording)





Photograph courtesy of NASA

## SIMPLER SOLUTIONS FOR A WIDE RANGE OF APPLICATIONS

### AUTOMOTIVE

The OR2300's simplicity and flexibility are ideal for the wide variety of testing performed by today's automotive engineers. Advanced Dot Overlap technology continuously records, in real time, the fast vibration details in wind tunnel testing. Direct thermocouple inputs simplify the numerous temperature measurements such as those in ignition coil testing.

### AEROSPACE

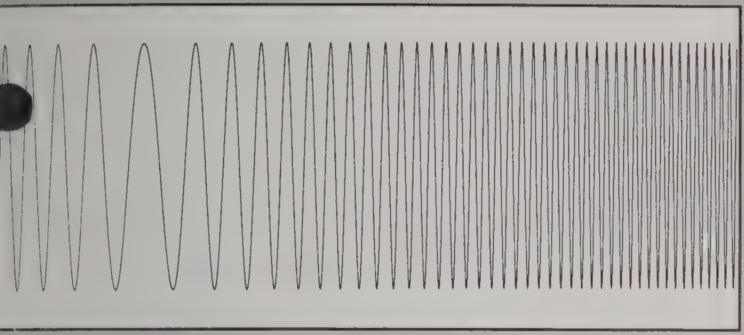
Wing vibration tests take advantage of the OR2300's multiple channel capability to respond at high speeds. Tests of long time duration show clear results due to the advanced Dot Overlap technology that records continuously while maintaining superb quality.

### STEEL

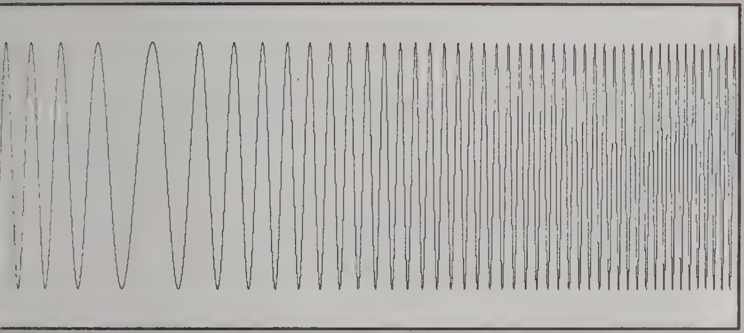
For steel coil thickness, and other process monitoring, the OR2300 will record general trends using slow chart speeds, and record irregularities to memory when triggered. This memory data can be automatically expanded to show details. The OR2300 can then return to the slower monitor mode. The multi-channel, maintenance-free operation, simplified setting adjustments, and event input for each channel make the OR2300 the ultimate recording solution in steel and other processing industries.

### POWER UTILITIES

For remote site monitoring and fault diagnostics, the OR2300's advanced triggering, long memory and excellent recording quality get **all** the facts on paper reliably and easily. And the lightweight OR2300 can be readily carried to field test sites – providing complete capabilities in one portable package.

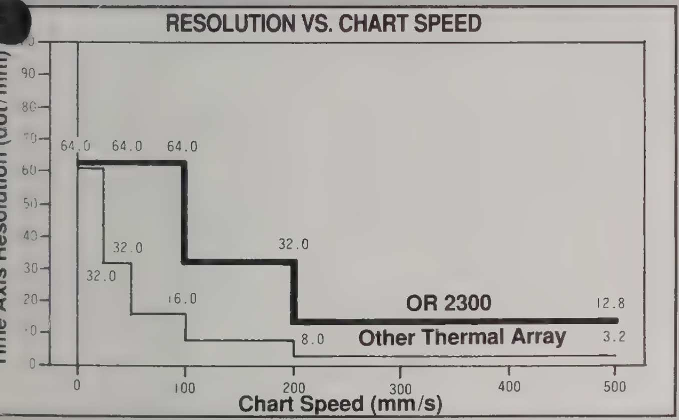


ITH DOT OVERLAP



ITHOUT DOT OVERLAP

*ot Overlap Technology provides 4 times better time axis resolution than conven-*
*onal thermal array recorder technology.*



*The OR2300 maintains high quality recording even at the highest chart speeds, thus providing greater detail of your data.*

# EXCLUSIVE "DOT OVERLAP" TECHNOLOGY REVEALS ALL THE DETAILS

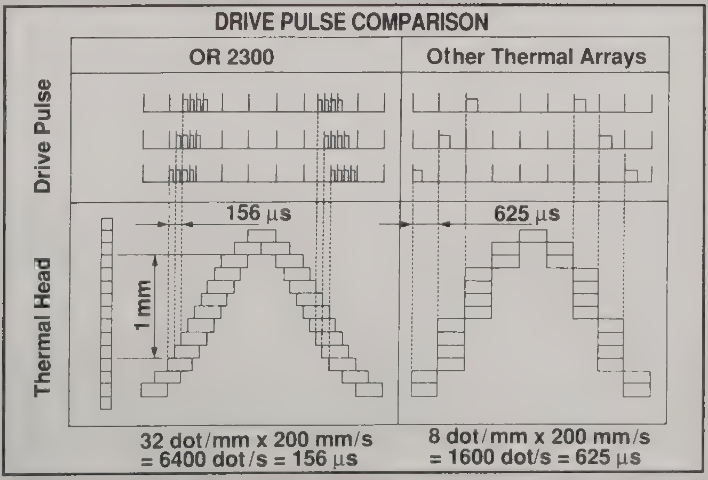
Yokogawa's "Dot Overlap" technology generates recording quality that is **four times** better than conventional thermal array recorders, exceeding laser printer resolution quality at even the highest chart speeds. This system eliminates the stair-step trace appearance seen in all other thermal recorders at high recording speeds. Thus, it reveals fast events and details that poor print quality might otherwise obscure.

For high speed recording, time axis resolution is most critical. It is determined by two things: (1) the printhead control method and (2) the chart speed. Yokogawa's patented "Dot Overlap" technique represents a major breakthrough in printhead control. "Dot Overlap" controls the printhead much faster than conventional methods. With faster printhead control, a second dot's printing cycle can begin while a first dot's cycle is still in progress. The result is a finer, smoother trace – so you can see all the events of interest.

The difference in resolution and print quality between "Dot Overlap" and conventional thermal array recording is similar to the difference between laser and dot matrix printers. Laser printers have resolution of 300 dots per inch (dpi), or about 12 dots/mm (dpm). The OR2300 exceeds this resolution at **all** chart speeds – even at the fastest 500 mm/s. On the other hand, at 500 mm/s conventional thermal array resolution is only 75 dpi or 3.8 dpm.

In fact, "Dot Overlap" resolution at the commonly used chart speed of 200 mm/s, is 800 dpi or 32 dpm, (2.7 times **better** than laser printer resolution). Conventional thermal arrays fall short of laser printer resolution above 100 mm/s chart speeds.

*With the OR2300's faster, more flexible printhead control, the time until a second print cycle begins is shortened to 156 µs–allowing it to begin while the first cycle is still in progress.*



# SPECIFICATIONS

## MEASUREMENT

**No. of Channels**
Analog: 8 (isolated, non-isolated), 16 (non-isolated)
Event: 17 TTL level, 1 panel key

**Frequency Bandwidth**
DC coupled input: DC to 40 kHz (-3 dB, typical)
AC coupled input: 1 Hz to 40 kHz (-3 dB, typical)
(Non-isolated model is 20 kHz max)
Temperature input: DC to 6 Hz (-3 dB, typical)

**A/D Resolution**
16 bit ADC, 14 effective bits

**Maximum Allowable Input Voltage**
30 Vrms AC, or 60 V DC

**Input Impedance**
Approx. 1 MOhm

**Filter**
Off, 1.5 Hz, 40 Hz, 400 Hz, 4 kHz

**Sampling**
Isolated model 100 kSample/s; Non-isolated model 50 k Sample /s

**Maximum Common Mode Voltage (Isolated Model)**
30 Vrms AC

**Normal Mode Rejection**
50 dB (50/60 Hz, 1.5 Hz filter ON)

**Common Mode Rejection**
120 dB (50/60 Hz, 1.5 Hz filter ON)

**Ranges and accuracy: See tables below**

### DC VOLT INPUTS

| Range | Full Scale Values | Accuracy | Resolution |
|---|---|---|---|
| 50mV | ±50.00mV | ±(0.5% of F.S.+50µV) | 5µV |
| 100mV | ±100.00mV | ±(0.3% of F.S.+50µV) | 20µV |
| 200mV | ±200.00mV | ±(0.25% of F.S.+50µV) | 20µV |
| 500mV | ±500.00mV | | 50µV |
| 1V | ±1.000V | | 0.2mV |
| 2V | ±2.000V | | 0.2mV |
| 5V | ±5.000V | | 0.5mV |
| 10V | ±10.00V | | 2mV |
| 20V | ±20.00V | | 2mV |
| (50V) | (±50.00V) | | (5mV) |

50V range is available on isolated models only.

### THERMOCOUPLE INPUT (isolated input model only)

| Range | Range of Measurement Capability | Accuracy |
|---|---|---|
| K | -200.0 ~ 1300.0 °C | ±(0.2% of rdg + 1.5 °C) |
| E | -200.0 ~ 800.0 °C | Except -200 ~ 0 °C: |
| J | -200.0 ~ 1100.0 °C | ±(0.5% of rdg +1.5 °C) |
| T | -200.0 ~ 400.0 °C | |
| L | -200.0 ~ 900.0 °C | |
| U | -200.0 ~ 400.0 °C | |

*Does not include reference junction compensation accuracy.
Reference junction compensation accuracy: ±0.8 °C

## RECORDING

**Recording System**
**Dot Overlap** thermal array recording

**Recording Functions**
Real-time recording: Y-T, X-Y, logging recording, event recording

**Memory Data Playback Recording**
Y-T, X-Y, logging recording

**Recordable Information**
Measured data, memory data, setup information (list print), units, scaling values, message, header, time ticks, grids, time of day, channel ID, chart speed, effective chart speed, trigger point

**Effective Recording Width**
Approx. 375 mm

**Recording Accuracy**
Measuring accuracy ± 0.125 mm (1 dot)

**Amplitude Recording Resolution**
8 dots/mm

**Time Axis Resolution**
800 dpi or 32 dots/mm at 200 mm/s
325 dpi or 12.8 dots/mm at 500 mm/s

**Chart Speed**
Real Time: 10 mm/hr-500 mm/s
Memory Playback: 25 mm/s fixed

**Chart Feed Accuracy**
± 0.05 % (1 m feed)

**Single Shot Advance**
Automatically records a specified length (0.5, 1, 2, or 5 m) of chart

**Recording Trace Intensity**
2 levels (select Light or Dark for each channel)

**Recording Paper**
100 m Z-fold or roll

## MEMORY FUNCTION

**Memory capacity : See table below**

### MEMORY FUNCTION

| Memory Capacity | k data / Waveform | |
|---|---|---|
| | Standard | Coupled |
| 64 kdata/ch<br>(isolated / non-isolated) | 1,2,4,8,16,32,64 | 125 |
| 256 kdata/ch<br>(non-isolated) | 1,2,4,8,16,<br>32,64,125,250 | 500 |
| 512 kdata/ch<br>(isolated) | 1,2,4,8,16,32,<br>64,125,250,500 | 1000 |

**Memory modes**
Standard, coupled, and partitioned

**Number of Partitions**
1, 2, 4, 8,16

**Sample Rate**
0.1, 0.2, 0.5,1, 2, 5,10, 20, 50, 100, 200, 500,1k, 2k, 5k, 10k, 20k, 50k,(100 kHz on isolated models)

**Memory Data Output**
Recording, display, and communications

**Recording Appearance Modification**
Expand or reduce time axis by changing the readout rate

**Computation Functions**
Maximum, minimum, average, root mean square (RMS)

## TRIGGERING

**Trigger Action**
Record or Memory capture

**Trigger Mode**
Free, Single, Repeat

**Trigger Source**
INT (internal) or EXT (external TTL level)

**Trigger Level**
High, Low; -100% - 100% (1% increments)

**Trigger Slope**
Rise, Fall

**Trigger Combinations**
AND or OR on any four channels

**Pre-trigger**
0 to 100%, adjustable in 10% increments

## DISPLAY

**Screen**
12.7 cm / 5"EL.320 x 256 pixels

**Displayed Information**
Settings and measurement data-waveforms or digital (Waveforms not displayed during recording on 16 ch models)

**Measured Value Display Formats**
Y-T : Displays waveform in real time, (8 ch)
X-Y : Displays one selected Y axis input, (Memory data)
Logging: Displays digital values for all channels, updated every 0.5 seconds

## GENERAL SPECIFICATIONS

**Operating Environment**
0 to 40 °C, 30% to 80% RH (non-condensing)

**Warm-up Time**
At least 30 minutes

**Withstand Voltage**
1,500 VAC for 1 minute between power supply and ground, between input terminals and ground, and between input terminals

**Insulation Resistance**
10 MOhm between power supply and ground, between input terminal and ground, and between input terminals at 500 V DC

**Input Signal Source Resistance**
500 Ohm max.

**Clock Accuracy**
±50 ppm (typical)

**Battery Backup**
Lithium battery for settings & clock. Life: 10 yrs.

**Specified Power Supply**
100-120 VAC / 200-240 VAC
50/60 Hz
Auto-selected

**Allowable Power Supply**
90-132 VAC/180-250 VAC
48-63 Hz

**Power Consumption**
When recording - 100V: Max 1000 VA, 600 W Max
200V: Max 1200 VA, 600 W Max
When not recording - 100V: Max 160 VA, 80 W Max
200V: Max 240 VA, 80 W Max

**Weight**
18 kg / 40 lbs.

**Safety**
CSA231 and IEC1010 applied for

**Other**
Physical key lock

## IC MEMORY CARDS (SOLD SEPARATELY)

**Memory Capacity**
1 MB, 512 KB, 256 KB, 64 KB

**Memory Content**
Setting values, measured values

**Measured Values**
User can specify any desired portion of waveform memory for storage

**Data Playback**
Measured data stored on an IC memory card can be displayed on the screen and recorded on the chart

## EXTERNAL INPUT/OUTPUT

Trigger In/Out, External Clock, Start/Stop, External Chart Feed, Event Input, TTL Level

## OPTIONS

**GP-IB Interface**
Conforms to IEEE St'd 488-1978

**Functions**
Settings input/output and measured value output

**RS-232-C Interface**
Conforms to EIA RS-232-C
Transmission rate: 75-9600 baud
Functions: Settings input/output, measured value output

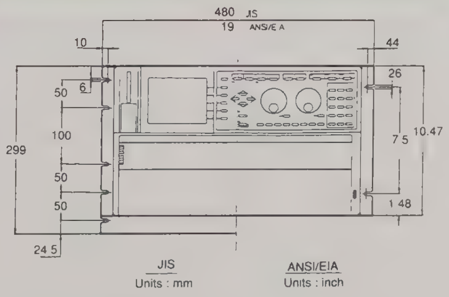
**PC Keyboard Interface**
Connection for IBM AT* style keyboard used for all settings except rotary knob and chart speed key settings. Especially useful for alphanumeric input

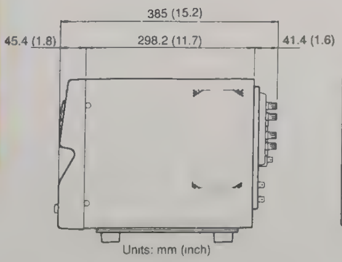
**Event Input**
16 channel event inputs recorded next to each channel input. TTL or contact

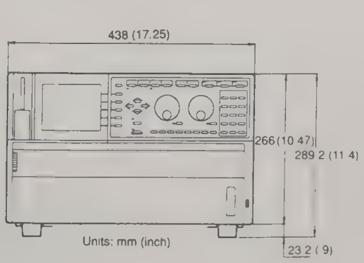
**Roll Chart**
Includes roll chart flange and cutter

## OPTIONAL ACCESSORIES

| Name | Code | Description |
|---|---|---|
| Rack Mount Kit | 379815 | Use with JIS racks |
| Rack Mount Kit | 379816 | Use with ANSI racks |
| Roll Paper Flange | 379821 | Mount for /H1 option |
| Roll Paper Cutter | 379822 | Cutter for /H1 option |
| Power Unit | 365961 | 2 channels each (V, A) |
| Measurement Lead | 366961 | Banana clip (1 m) |
| Conversion Adaptor | 366921 | BNC-Banana |
| Conversion Adaptor | 366922 | Banana-BNC |
| Plug Adaptor | 366923 | T-shaped |
| BNC Cable | 366924 | BNC-BNC (1 m) |
| BNC Cable | 366925 | BNC-BNC (2 m) |
| Clip Lead | 366926 | BNC-clip (1 m) |
| IC Memory Card | 378903 | 64 Kbytes |
| IC Memory Card | 378904 | 256 Kbytes |
| IC Memory Card | 378905 | 512 Kbytes |
| IC Memory Card | 378906 | 1 MB |
| Cleaning Kit | 700921 | For screen |







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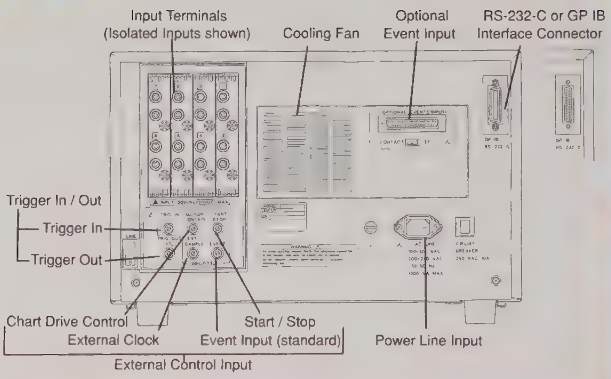

## AVAILABLE MODELS

| Model | | Suffix Code | | Description |
|---|---|---|---|---|
| 7801 | 11 | | | 8 ch Non-isolated 64 KWord/ch Memory (D-RAM) |
| Input Channels and Memory | 12 | | | 8 ch Non-isolated 256 KWord/ch Memory (D-RAM) |
| | 13 | | | 8 ch Non-isolated 256 KWord/ch Memory (S-RAM) |
| | 21 | | | 8 ch Isolated 64 KWord/ch Memory (D-RAM) |
| | 22 | | | 8 ch Isolated 512 KWord/ch Memory (D-RAM) |
| | 23 | | | 8 ch Isolated 512 KWord/ch Memory (S-RAM) |
| | 31 | | | 16 ch Non-isolated 64 KWord/ch Memory (D-RAM) |
| | 32 | | | 16 ch Non-isolated 256 KWord/ch Memory (D-RAM) |
| | 33 | | | 16 ch Non-isolated 256 KWord/ch Memory (S-RAM) |
| Power Cord | | -P | | ULCSA Approved (AC 125V 10A) |
| | | -F | | VDE Approved (AC 250V 10A) |
| | | -G | | SAA Approved (AC 240V 10A) |
| | | -S | | BS Approved (AC 250V 10A) |
| | | -N | | ULCSA Approved with ground connector (AC 125V 10A) |
| Options | | | /C1 | GP-IB Interface |
| | | | /C2 | RS-232-C Interface |
| | | | /C5 | External Keyboard Interface |
| | | | /N3 | Event Input (16 ch) |
| | | | /H1 | Roll Chart Adaptor and Cutter |

## SPARES

| Name | Part No. | Description | Order Qty. |
|---|---|---|---|
| Roll Chart | B9886AJ | 100m | 1 roll |
| Z-Fold Chart | B9886AH | 100m | 1 chart |
| Lithium Battery | B9586JU | Use for 3789 03 | 2 |
| Lithium Battery | B9586JV | Use for 3789 04, 05, 06 | 2 |

## PERIPHERAL EQUIPMENT

| Name | Part No. | Description |
|---|---|---|
| DC Amplifier | 3132 | Input Resistance: about 1MΩ<br>Voltage Gain: 0.1 - 100<br>Linearity: ± 0.05% of Full Scale<br>Maximum Output: ± 10V / ± 50mA |
| DC Amplifier | 3133 | Channels: 2<br>Input Resistance: about 150 kΩ<br>Linearity: ± 0.05% of Full Scale<br>Maximum Output: ± 10V / ± 50mA |
| DC Amplifier | 3131 | Input Resistance: about 10 MΩ<br>Voltage Gain: 0.1 - 10,000<br>Linearity: ± 0.05% of Full Scale<br>Maximum Output: ± 10V / ± 50mA |
| Signal Conditioner | 3458 10<br>3458 20 | Maximum Sensitivity: 100 mV/100 x $10^{-6}$ strain (345810)<br>Gain: 100-2,000 (345820)<br>Linearity: ±0.01%<br>Band Limit: 10 / 30 / 300 Hz / 3kHz / OFF<br>Maximum Output: ± 10V / ± 50mA |
| Strain Amplifier | 3134 01<br>3134 02 | Range: ± 200 - ± 10,000 x $10^{-6}$ strain<br>Max. Sensitivity: 0.5V/10 x $10^{-6}$ strain<br>Output Voltage: ± 10V/± 50 mA |
| Series Resistor | 3105 | Channels: 2<br>Resistance: 1-500 kΩ<br>Current Limit: 200V or 40mA rms |
| Series Resistor | 3106 | Channels: 2<br>Resistance: 0.2Ω (0-100% variable)<br>Current Limit: 5A rms |
| F-V Converter | 3161 | Range: 6 - 600,000 rpm, 0.1 Hz - 10kHz<br>Maximum Input: ± 100V<br>Input Resistance: 100 kΩ |

YOKOGAWA

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YOKOGAWA ◆

# AR 1100

## Analyzing Recorder

## *Powerful Waveform Measurement in a single compact package*

*In the field or lab, your engineering productivity can be greatly increased by using an entirely new, powerful waveform measuring instrument; YOKOGAWA AR1100 Analyzing Recorder.*

*Have you ever faced cumbersome jobs like preparing, installing, wiring and operating a number of measuring instruments at one time?*

*AR1100 provides a convenient solution to such problems. Into an easy-to-carry, single package, AR1100 consolidates all the functions needed for waveform measurement, including measuring, computing, display and powerful recording functions.*

Bulletin 7021-E

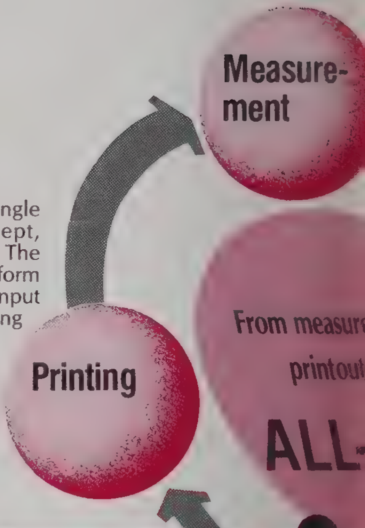
# *All the functions needed for waveform measurement in a single unit ! From measurement to a hard-copy in the shortest possible time !*

## *..... An easy-to-use waveform measuring instrument that will meet the needs of engineers in many fields*

# AR1100

### YOKOGAWA's "All-In One" Concept

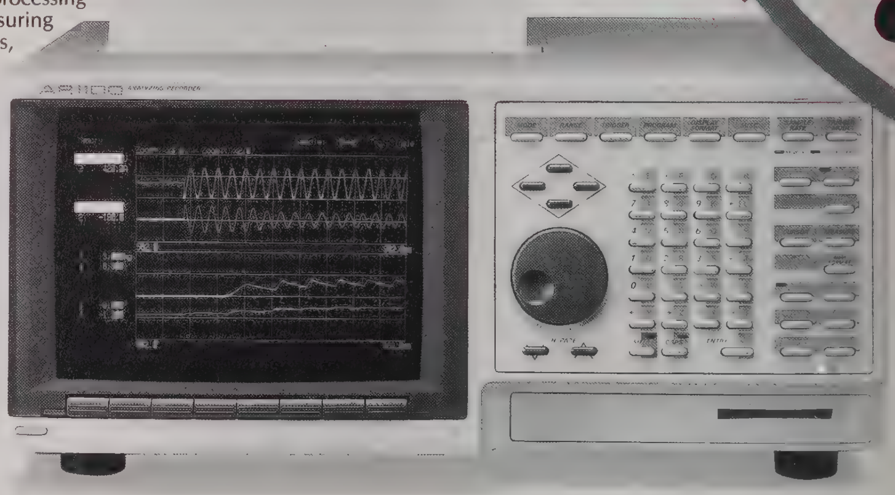
All the functions required for measurement in a single unit. YOKOGAWA's "All-in-One" concept, implemented in the AR1100 analyzing recorder. The AR1100 incorporates everything needed for waveform measurement, from the measurement of the input signals, through processing and display, to printing out - in a single unit.



This all-in-one configuration has everything needed to perform a wide variety of measurement and analysis jobs, in their entirety. It samples and stores input signals from low to high speed, analyzes them, displays them on its CRT and prints out a hard copy for inclusion in a report.

On its own, the AR1100 can perform the processing that until now had required several measuring instruments. Using simple key operations, the AR1100 can carry out the optimum combination of measurement, analytical processing and display, and print out the results immediately.

The AR1100 is ideal for engineers working in many fields of industry, electrical appliances, electric power, electronics, automotive, machinery, plant, construction, and scientific applications. The AR1100, the birth of a new era in waveform measurement.



**Memory mode**

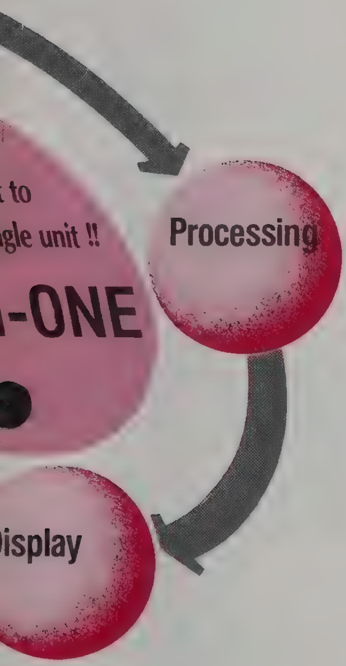
- For the storage, processing, analysis, display and printing out of high-speed and low-speed phenomena
- X-Y display and print-out
- Waveform go/no-go judgment function

**Recorder mode**

- Real-time continuous recording
- Data logging
- Temperature measurement

**FFT mode**

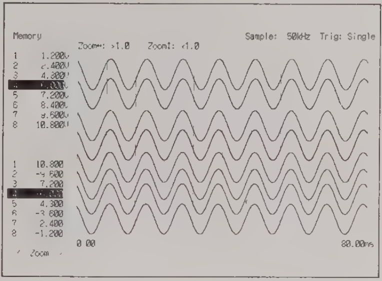
- Frequency analysis
- Transfer function



## Simultaneous measurement of multiple phenomena with large memory capacity

### 8 isolated input channels

The AR1100 has a maximum of eight input channels and each channel has its own A/D converter, making possible simultaneous sampling. It can measure up to eight completely different phenomena . . . voltage, current, temperature, strain, displacement, pressure, vibrations, sound level, etc. . . . simultaneously and with no time delay, and the waveforms of these phenomena can be displayed on the screen and printed on a chart. Since each channel is electrically isolated, measurements will be highly reliable even when channels have different ground potentials.



### 512k words/channel

The maximum memory capacity of the AR1100 is 512k words per channel. This is particularly useful when recording a phenomenon over a long period. For example, with a sampling rate of 1 sample per second (1 S/s), measurement can be continued for over 138 hours with data captured at 500,000 points. (When the programmable processing and averaging functions are not used).

If the number of channels is halved by using only odd-numbered channels, 1M words are available per channel, for more effective use of memory.

### High-resolution 14-bit A-D converters

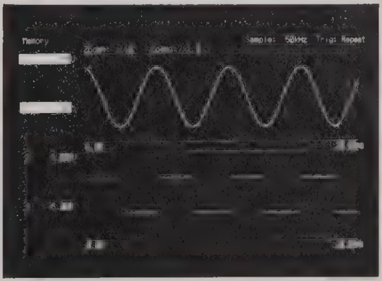
Using 14-bit A-D converters which operates at 100 kS/s, the AR1100 has high resolution throughout its wide dynamic range. High resolution and wide dynamic range are essential when waveform data is to be analyzed by performing computations between channels, the computation of maximum and minimum value statistics, and frequency analysis.

With 1 S/s sampling, data from 500k points collected over 138 hours

## High-speed display and printing

### High-speed display

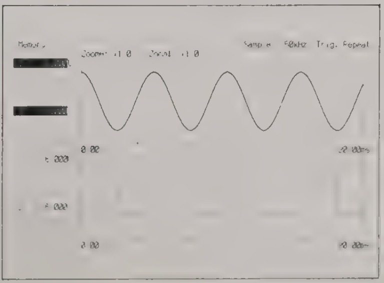
The AR1100 also has high-speed hardware architecture in its display processor, for a higher response speed. In the memory mode, even the simultaneous display of 125k words of data on each of 8 channels can be achieved within about 1 second after measurement is complete (when the programmable processing function is not used). With this, there is almost no waiting for displays using large quantities of data, so that measurement jobs are significantly faster.



### Hard copies of screen displays at 8 s/A5 sheet Continuous recording at 50 mm/s

The AR1100 incorporates a high-speed thermal printer with a width of 210 mm (8¼").

Hard copies of waveforms, setup parameters and other data displayed on the screen can be made on A5 chart paper in just 8 seconds. In the continuous recording mode, the maximum chart speed is 50 mm/s. The high quality of these hard copies is one of the AR1100's most important features.

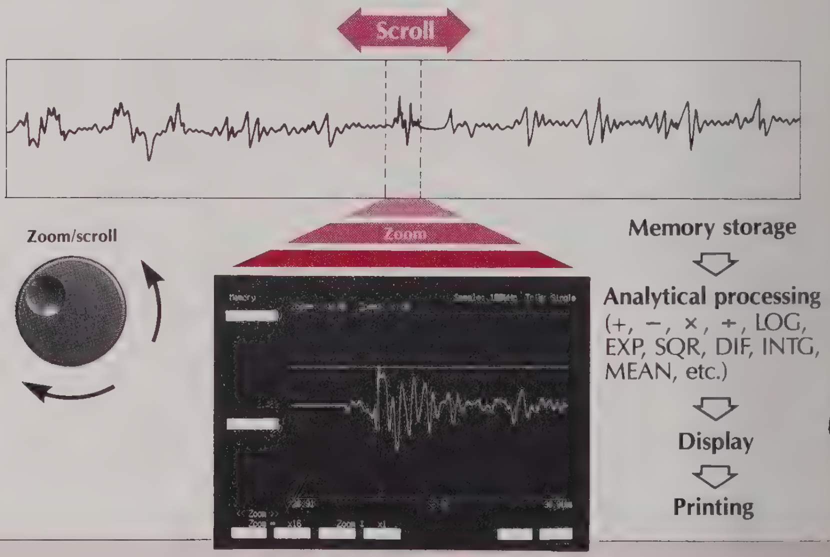


# Three basic functions

## The storage, analysis, display and printing out of all phenomena, from low to high speed . . . Memory mode

After an input waveform has been saved in memory and analyzed, the memory mode is used to display and print out only the required parts of the waveform. This is ideal for the analysis and measurement of single-shot and repetitive waveforms at all speeds.

Input waveforms from up to eight channels can be stored at the same time, thanks to the independent large-capacity memories. If waveform analysis is required, available functions include basic arithmetic, scaling, inter-channel computations, differentiation and integration, together with waveform go/no-go judgments; then, using zoom and scroll, you can call up an expanded display of any required part of the waveform. Both time-axis (T-Y) displays and X-Y displays are possible. The display which appears on the CRT can then be printed out on an A5 or A4 sheet for inclusion in a report, or it can be printed on a continuous chart. The AR1100 can do anything that would conventionally be done using an oscilloscope, a waveform memory, a pen recorder, or an X-Y recorder; at the same time, it has extensive analytical processing functions. The AR1100 is ideal for use in automated measurement systems, advancing measurement quality to a new level of excellence.



Memory storage

⇩

Analytical processing (+, −, ×, ÷, LOG, EXP, SQR, DIF, INTG, MEAN, etc.)

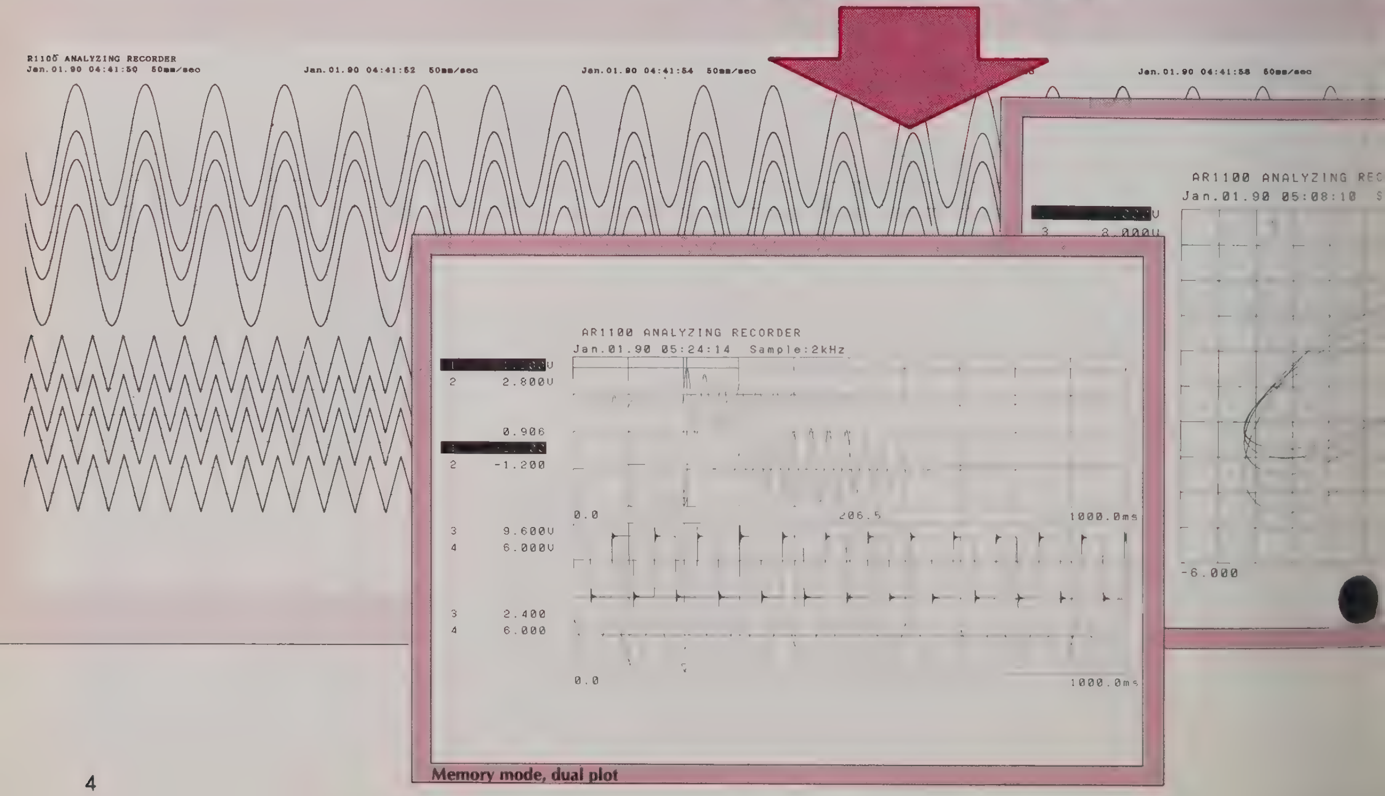
⇩

Display

⇩

Printing

**Clear printouts in a variety of formats (examples of printouts)**


R1100 ANALYZING RECORDER
Jan.01.90 04:41:50 50mm/sec
Jan.01.90 04:41:52 50mm/sec
Jan.01.90 04:41:54 50mm/sec
Jan.01.90 04:41:58 50mm/sec

AR1100 ANALYZING RECORDER
Jan.01.90 05:24:14 Sample:2kHz

AR1100 ANALYZING REC
Jan.01.90 05:08:10

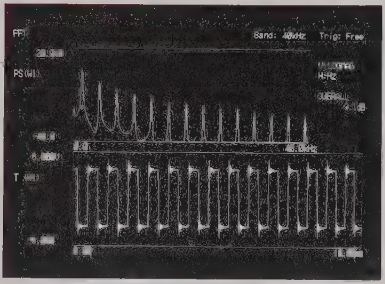
Memory mode, dual plot

### A long continuous recording time . . . Recorder mode

This mode is used for the real-time recording of data directly on continuous chart paper, without saving the input waveform data in memory. Up to eight channels can be recorded simultaneously. While measurement is in progress, the waveform appears moving across the screen of the CRT from right to left; when the required part of the waveform is seen, recording can be started (and later stopped) manually, so that recording paper is not wasted. The maximum chart speed is 50 mm/second, fast enough for almost any application. Waveform data can also be printed out in the form of a digital log.

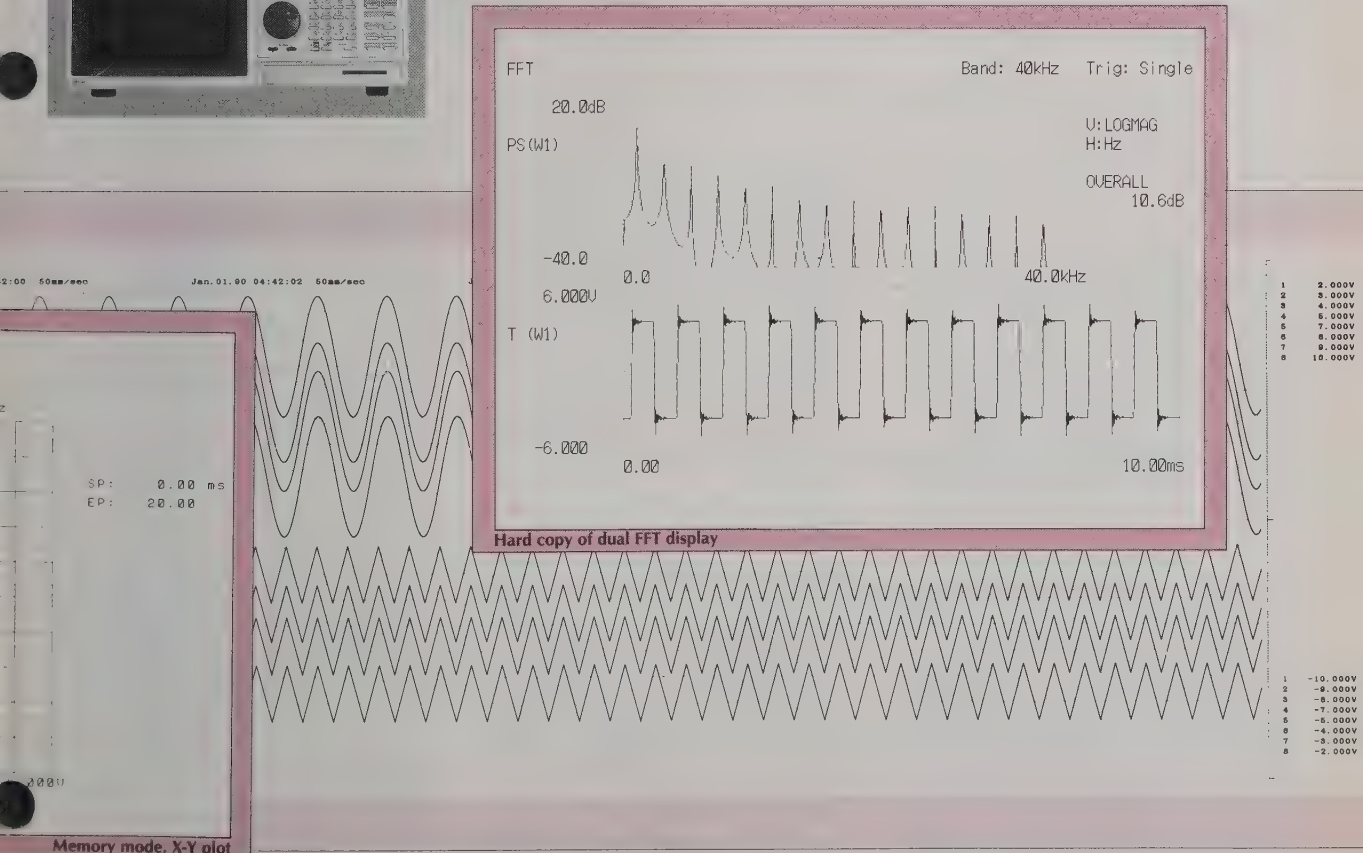
With the AR1100, you can perform any measurement that would conventionally use an electromagnetic oscillograph, pen recorder, pen oscillograph, temperature recorder, data logger, etc.

### Frequency analysis . . . FFT mode (optional)



The AR1100 can be used as a 2-channel FFT analyzer, with a maximum frequency range up to 40 kHz. The FFT mode is used for the frequency analysis of sound, vibrations, electrical signals, and for transfer function analyses of components and structures.

Frequency analysis of waveform data captured in the memory mode can be performed in the FFT mode.



Hard copy of dual FFT display

Memory mode, X-Y plot

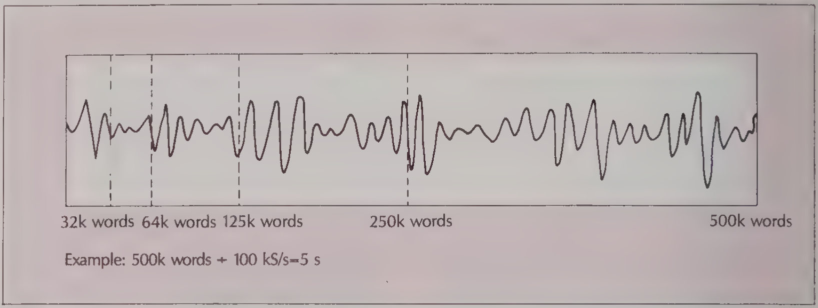
Recorder mode

# Storage, analysis, display and printing out of all phenomen

## Large capacity 512k words/channel memory

1M words/channel also possible using only odd-numbered channels

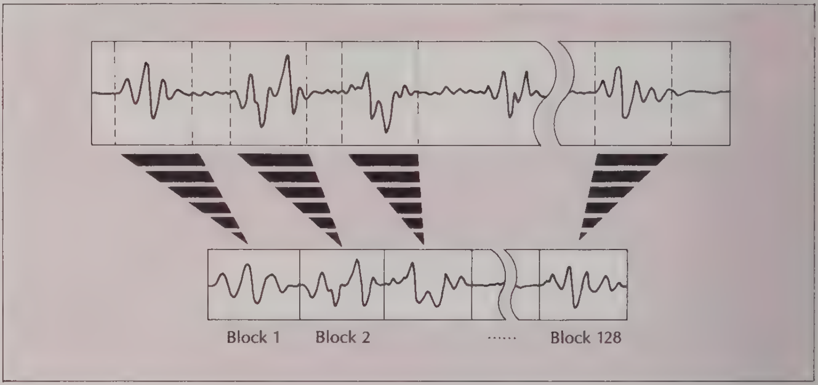
The AR1100 has a large maximum memory capacity . . . 512k words/channel. By halving the number of channels, using only odd-numbered channels, this memory capacity can be increased to 1M words/channel. This feature is most useful for the measurement of single-shot phenomena over long periods. Because so much memory is provided, long-term measurement is possible without reducing the sampling speed. Another advantage of the AR1100 is its powerful pretrigger function which can be used to capture waveforms ahead of their triggers, for signals the timing of which is unknown.



Example: 500k words ÷ 100 kS/s=5 s

### Memory partitions (up to 128) . . . Sequential memory function

Waveform memory can be partitioned into a number of blocks, which are used in sequence to store the instantaneous waveform each time a trigger is generated. The 512k-word memory can be partitioned into a maximum of 128 blocks, each of 4k words. This is another feature making possible more efficient use of the available memory.

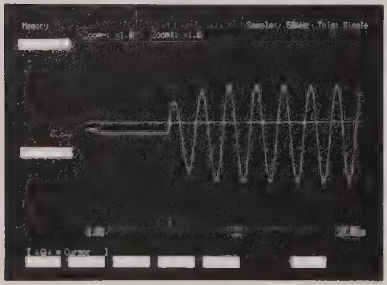


## Powerful trigger functions

Up to four analog input triggers can be set for internal triggering. Each trigger can be set to be effective when the signal is on or off, and the user can select the source channel, trigger level, and trigger slope or logic state (rising edge or falling edge, high level or low level) individually for each trigger. For greater flexibility, AND or OR gating of individual triggers is possible. By combining these features, the user can employ a wide variety of triggering modes, including AND, OR, window, and bi-slope triggering. These make it possible to capture complex waveforms that in the past would have been difficult to observe. External triggering is also possible.

### Pretrigger

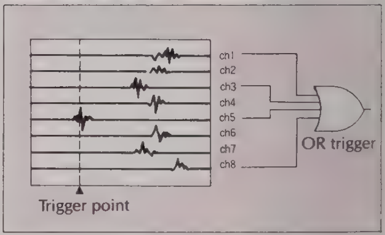
Pretriggering can be used to capture waveform data that occurs before the trigger. The amount of data to be captured by pretriggering can be set in multiples of 10%, from 0% to 100% of the memory length.



(Triggering Examples)

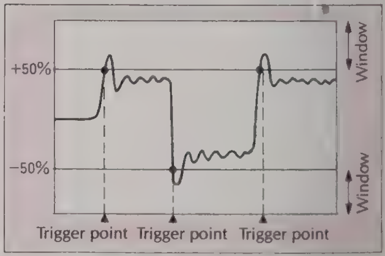
### OR trigger

An OR trigger can be set for any of up to four input channels. When a trigger occurs in any one of the four channels, the waveforms from all channels are captured. This technique is useful in monitoring failures and similar applications, for triggering when any of several phenomena could occur on any channel.



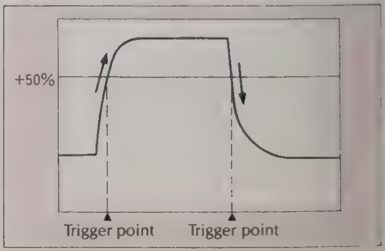
### Window trigger

One example of the use of window triggering is for the observation of waveforms when they are outside a certain percentage of the input range. In applications such as the measurement of displacement, this can be used to set triggers for overshoots of a certain value, in both rising and falling transitions. In certain applications, it could also be used for triggering when the input waveform enters a band the upper and lower limits of which are a certain percentage of the input range.



### Bi-slope trigger

An example of bi-slope triggering is where triggering is required at both the positive-going and negative-going points where a signal passes through +50% of the input range. When used for the observation of a power supply, the AR1100 could be set to be triggered at both the rising and falling edges of the output of a DC power converter, allowing both rising and falling waveforms to be observed.

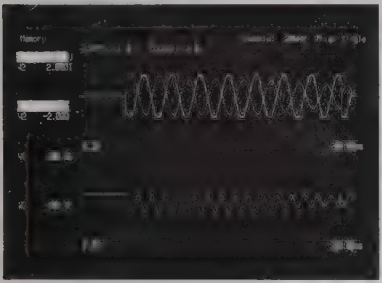


# rom low to high speed . . . Memory mode

## Computing power

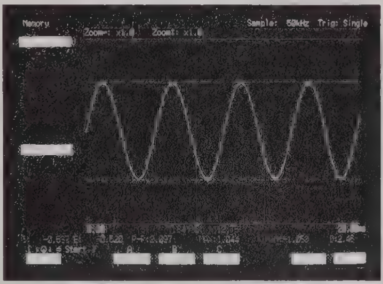
### Programmed computations

The AR1100's programmable computation functions can be used to perform a variety of processing such as inter-channel computations and the differentiation and integration of data from a measured waveform; the results can be displayed together with the waveform. Functions available include the four basic arithmetic operations (+, −, ×, and ÷), square root (SQR), logarithm (LOG), exponent (EXP), absolute value (ABS), moving average (MEAN), differentiation (DIF), double differentiation (DDIF), integration (INTG), double integration (IINTG), and trigonometric functions (SIN, COS, TAN, ASIN, ACOS, ATAN). These functions can be combined for the calculation of formulae. For example, an electric power waveform can be obtained by multiplying the voltage and current waveforms.



### Zone statistical computations

The maximum (MAX), minimum (MIN), peak-to-peak (P-P), average (AVE), root-mean-square (RMS), standard deviation (SD), and area (INTEG) values can be determined for the zone of the displayed waveform specified by two cursors.

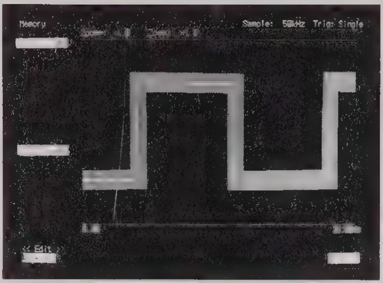


### Averaging

Random noise components in repetitive waveforms can be reduced using time-axis averaging. Averaging is possible up to 256 times.

### Waveform go/no-go function

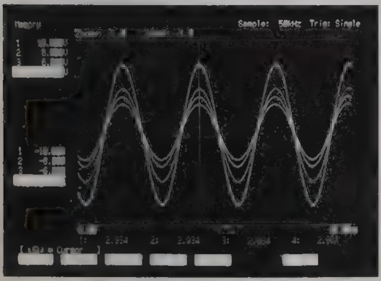
This function automatically checks whether or not the measured waveform meets certain specifications. The standard area can be defined by moving a measured waveform up and down and to the left and right on the screen; test conditions can also be stored on an IC card. The judgment checks whether the measured waveform is entirely within the standard area. You can also select that either only waveforms that fulfill the test conditions or only waveforms that fail to meet these conditions should be stored in sequential memory and printed out. The result of the judgment can also be output as a TTL signal from a GO/NOGO connector on the rear panel, to activate automated equipment. Waveform judgments can also be performed on waveforms processed by programmed computations and after averaging.



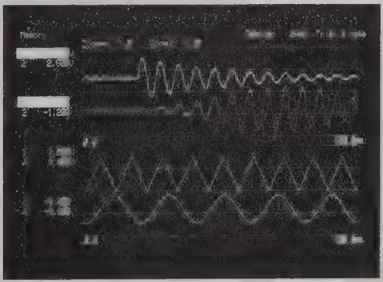
## Versatile display formats

Single, dual, quadruple and X-Y display formats are available. In the single and dual trace display modes, up to eight waveforms can be displayed simultaneously, while in the quadruple display and X-Y display modes, up to four waveforms can be displayed simultaneously on the CRT. By moving cursors to points on the waveforms, data values and times can be displayed on the screen. Within a single display, a multipoint cursor can be used to read data values for up to four waveforms at the same time. A reference cursor function can be used to measure the differences in amplitude and time between two points on a waveform. A grid function is available; by superimposing a grid over the display, it is easier to see the relative timing of several waveforms.

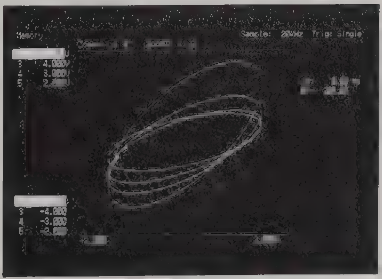
● Single display, multipoint cursor



● Dual display, and grid



● X-Y display

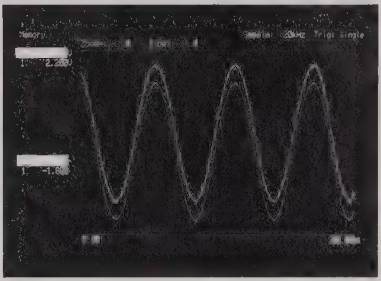


### Zoom and Scroll

With the T-Y and X-Y displays, the zoom function can be used to expand the display of the required section of a waveform. With the T-Y display, the scroll function can also be used to move the zoomed up display freely in either the time axis direction or the amplitude direction.

### Overlay

A waveform recalled from memory and newly measured waveform can be superimposed on the same screen.



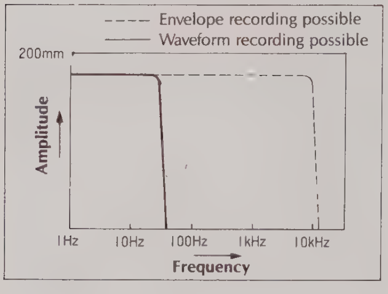
## Wide variety of recording formats

There are five recording formats available with the AR1100: a hard copy of what appears on the screen, plotting, analog recording, digital recording, and listing setup parameters. The AR1100's thermal printer can print out a hard copy of whatever appears on the screen, whenever required. A5 and A4 sizes can be selected; when A5 is selected, the entire contents of the screen are printed in just 8 seconds. Plotting prints out the displayed waveform in greater detail, on an A4 chart. When analog recording is selected, waveform data in a specified range can be recorded on a continuous chart with an extended time axis. Digital recording gives a digital record of data within a specified range.

# Continuous recording over long periods...Recorder mode

## High-definition recording at 50 mm/second on 210-mm chart paper

Up to eight channels can be recorded simultaneously on continuous chart paper. Standard chart paper is 210 mm (8 1⁄4″) wide and 50 m (164 ft) long and the recording speed can be selected in 15 steps from 10 mm/hour to 50 mm/s. In the recorder mode, the sampling speed is fixed at 100 kS/s and as the zone between the maximum and minimum values of measured samples is filled at the recording density of the thermal printer, the envelope waveforms of signals with frequencies up to about 10 kHz can be recorded. With the maximum chart speed of 50 mm/s, the waveforms of signals with frequencies up to about 60 Hz can be recorded in realtime. Digital data values for up to eight channels can also be printed, so the AR1100 can be used as a data logger.



### Roll screen

Using the roll mode, input waveforms for up to eight channels can be displayed in real time on the screen. The waveform moves from right to left across the screen, with the current point at the right edge. The user can observe the waveform on the screen and start printing out manually whenever required.

### Direct thermocouple inputs

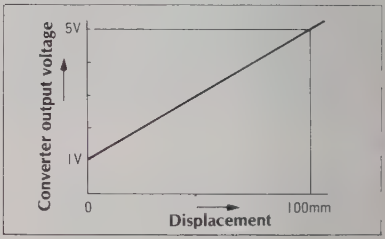
In recorder mode, the AR1100 accepts direct inputs from thermocouples for temperature measurement. Since reference junction compensation is computed in parallel during measurement, drift is minimized and stable recording is assured, even for temperature measurement over long periods. 11 types of thermocouples can be used . . . K, E, J, T, R, S, B, U, L, N, and W. Direct thermocouple input is also possible in the memory mode. The maximum sampling speed of thermocouple channels is 135 S/s.

### Time trigger

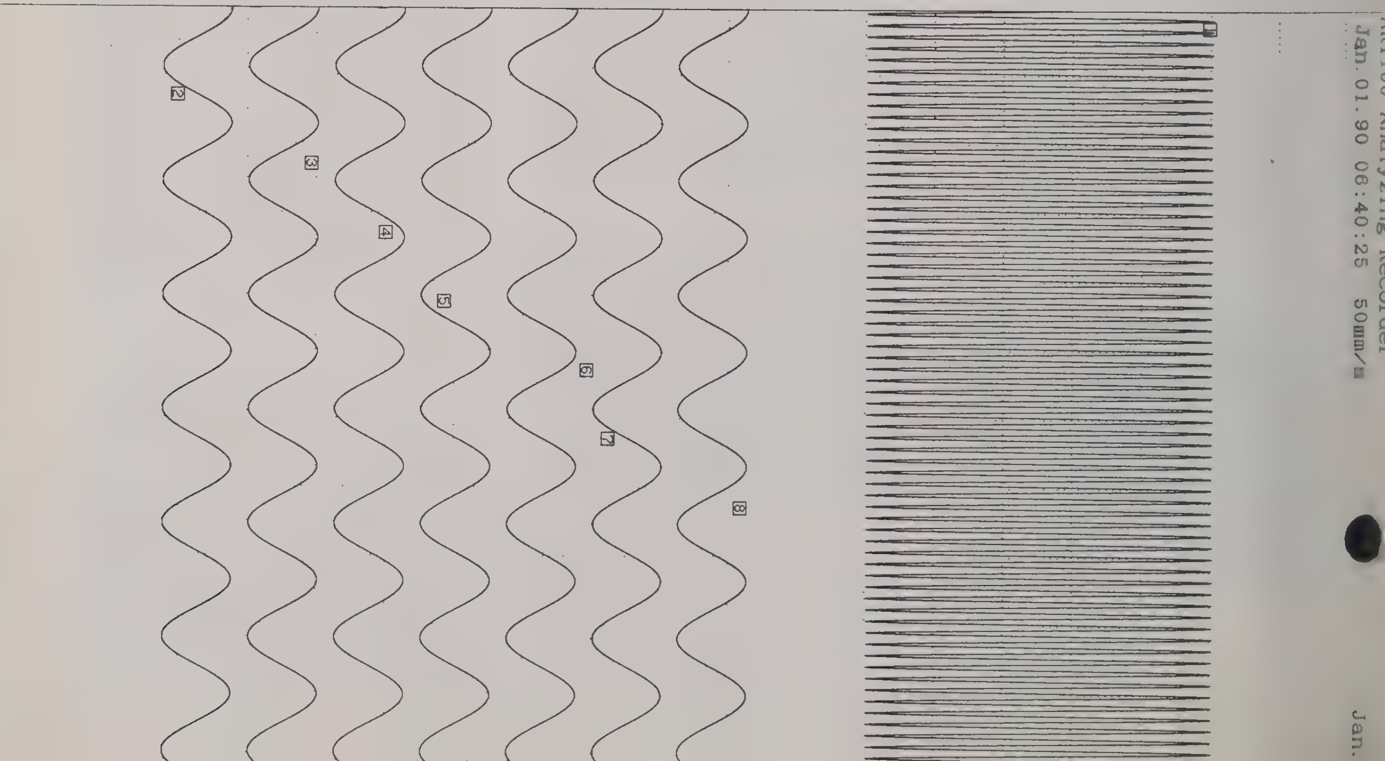
A time-of-day trigger is available in the recorder mode and can be used to set the time at which recording is to start and when it is to stop.

### Linear scaling function

If an external transducer is used when measuring a physical quantity such as strain, displacement, speed, acceleration or pressure, this linear scaling function can be used to read out the value of the physical quantity directly. For example, when a displacement gauge is used, the displacement can be read directly in mm units. This linear scaling function can also be used in memory mode, and has the advantages of being faster and using less memory than performing scaling by programmed computations.



## <Actual size>



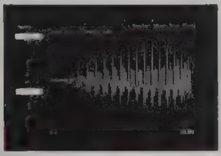
# Frequency analysis . . . FFT mode (optional)

## 2-channel FFT analyzer function

A signal's characteristics can often be understood more clearly by observing it in the frequency domain. The AR1100 can perform frequency analysis on any two of the eight input waveform channels, for signals in the frequency range from DC to 40 kHz. This feature can be used to perform frequency analysis of sound pressure levels, vibrations and electrical quantities, and to analyze transfer functions of components and structures. An anti-aliasing filter can be inserted ahead of the sampling circuit to prevent frequency components not actually present in the source signal from appearing due to aliasing. In addition, trigger and pretrigger settings can be specified in the same way as in the memory mode.

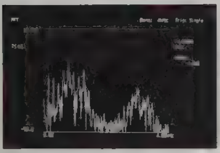
### Sharing data with memory mode

With the more usual 1024-point FFT analysis, sampling must be performed at 2.56 times the frequency range. Therefore, for signal in the 20 kHz range, sampling would have to done at 51.2 kS/s and, if this was done, the time axis would not have integer values, and fractions would be inevitable. To avoid this, the AR1100 FFT uses 1,000 sampling points. This has the advantage that data can be shared between the memory mode that handles the time domain and the FFT mode that handles the frequency domain, and there are no fractions in either time axis or frequency domain analysis. This means that for a 20-kHz signal, sampling is done at 50 kS/s. The frequencies of waveform data captured in the memory mode can be analyzed in the FFT mode, either directly or using an IC memory card.



Memory mode

IC memory card



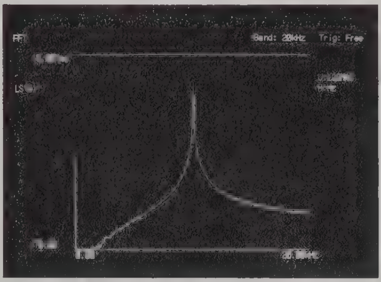
FFT mode

### DC to 40 kHz analysis 1/400 frequency resolution

Any of 13 frequency ranges can be selected, with top frequencies from 4 Hz to 40 kHz. The frequency resolution is a high 1/400.

### Dynamic range of 72 dB

With its independent 14-bit A-D converters, the AR1100 realizes the wide dynamic range of 72 dB for frequency analysis, more than enough for normal frequency analysis requirements.

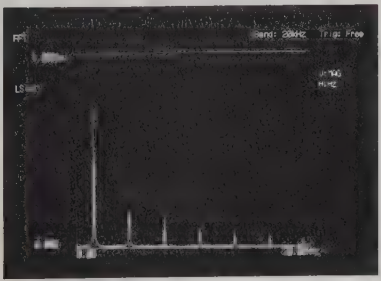


### Averaging function

Either time domain averaging or frequency domain averaging can be selected, and averaging can be performed up to 256 times. In time domain averaging, random noise components of repetitive signal waveforms can be reduced; in frequency axis averaging, continuous noise and vibrations can be averaged, so that the results of the analysis are more reliable. In addition, a peak hold function is provided to hold the level of each frequency peak along the frequency axis.

### Engineering unit (EU) function

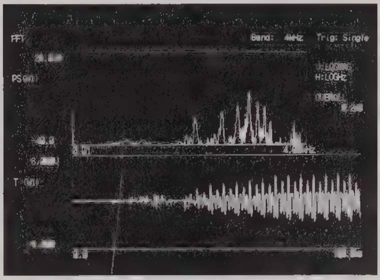
When using a transducer such as an accelerometer or noise level meter, frequency analysis results can be read directly as m/s$^2$, Gal, etc. For example, if an acceleration transducer outputs 1 V at 9.8 m/s$^2$, the acceleration can be read directly by simply setting EU/V = 9.8.



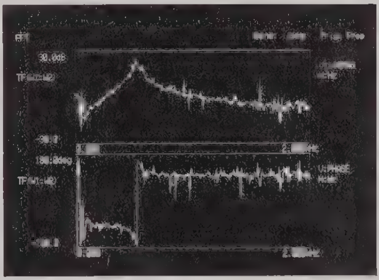
### Comprehensive range of analytical functions

Analytical functions provided in the AR1100 include linear spectrum (LS), power spectrum (PS), rms spectrum (RS), cross spectrum (CS), transfer function (TF), and coherence function (CH). To display the result of analysis, single trace, dual-trace and Nyquist display formats can be selected. Additionally, an array display format is also available. With single and dual trace displays, the cursors can be used for a direct read-out of the value after analysis at any point. The reference cursor can also be used to measure the differences in amplitude and frequency between two points

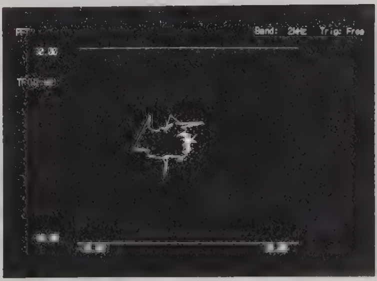
- Power spectrum



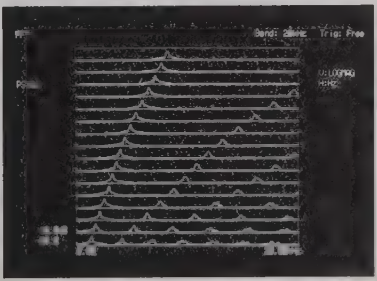
- Transfer function



- Nyquist display



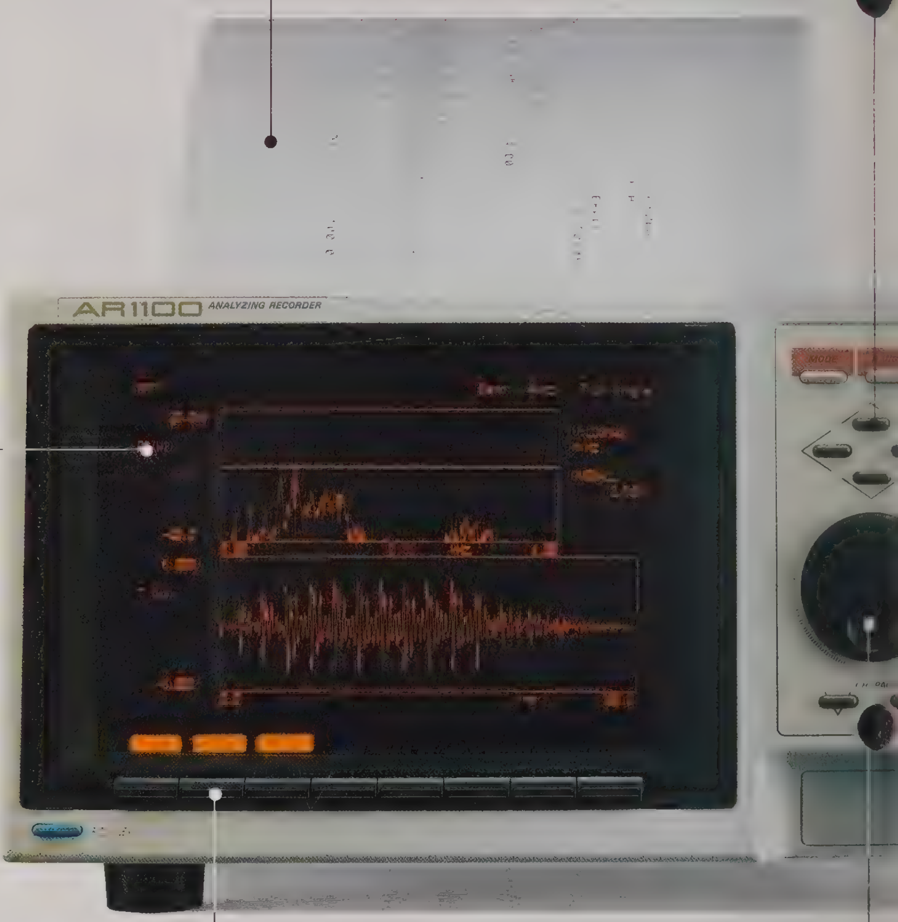
- Array display



# *All-in-one design · · · for multiple functions and simple oper*

**210-mm chart paper**
**High-resolution thermal printer**

The built-in thermal printer uses paper with a width of 210 mm (8¼"), for an A4 or A5 hard copy of whatever appears on the screen. In the continuous recording mode, printing is possible at the high speed of 50 mm/s. 50-m (164-ft) continuous charts can be used.



**Easy-to-view 9-inch screen**

Program settings, waveforms and digital values are clearly displayed on a large amber display, for fatigue-free viewing over long periods.

**Soft keys**

These correspond to the functions set by software and display in reverse video across the bottom of the screen, and are used to set the main parameters, etc.

**Rotary dial**

This is used to change the sampling speed, move the cursors, and to zoom and scroll in the memory mode.

## User-friendly design for easy operation

Setting the measurement conditions and other parameters is easy, using the function selection keys and soft keys through interactive operations referring to on-screen displays. For example, in order to set the input range, press the RANGE key to call up the range screen, select voltage measurement or temperature measurement with the soft keys, and then select the voltage range for voltage measurement, or the thermocouple type for temperature measurement. The input filter type can also be set referring to the on-screen menu.

### Cursor keys

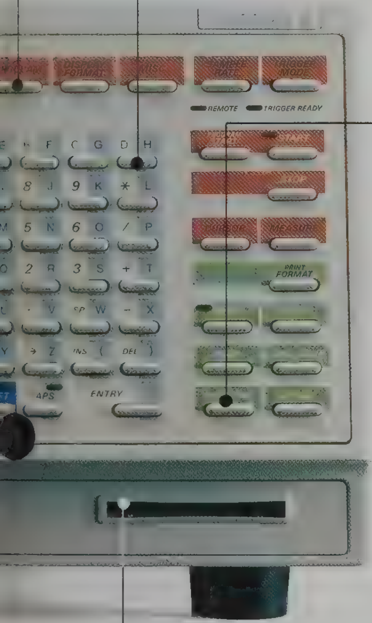
e cursor keys are used to select from rameters menus and to fine adjust the positions of cursors.

### Function selection keys

Used to set and change the modes, input ranges, trigger conditions, programmed computations, display format, etc. and to call up the various setup screens.

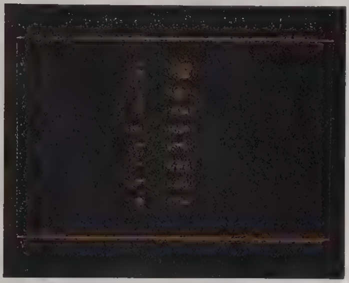
### Numeric keypad

Used to enter programs and to key in titles.



### Monitor key

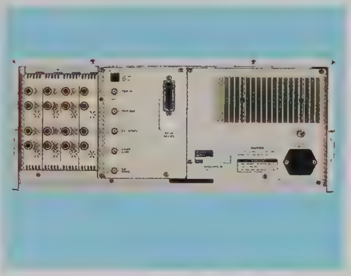
Press to display digital values for the eight simultaneous channel inputs on the screen.



### IC memory card slot

Waveform data, program data and setup parameters can be saved on an IC memory card, for quick loading in future.

## Rear Panel



GPIB/RS-232-C interface:

The communications functions allow full remote control from a personal computer or dedicated controller, and the uploading of measured and computed data. (Either a GPIB or RS-232-C interface can be installed as an option.)

TRIG IN connector:

External trigger signal input connector. TTL level signal.

TRIG OUT connector:

Trigger pulse output connector for parallel, synchronized operation of up to four AR1100 units.

EXT SAMPLE connector:

External sampling signal input connector. Enables an external signal to control sampling. TTL level signal.

START/STOP connector:

Input connector for external control of start/stop of measurements. TTL level or make-contact signal.

GO/NOGO connector:

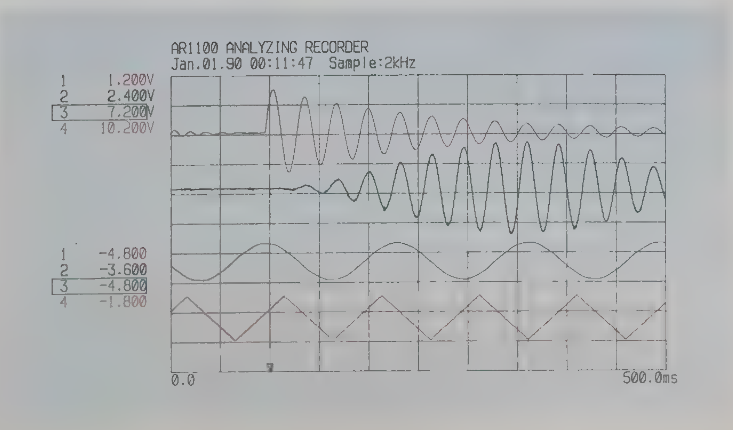
Output connector for GO/NOGO judgments. TTL level signal.

## HP-GL plotter output (when optional GPIB or RS-232-C interface is installed)

In addition to hard copies printed by the built-in thermal printer, when connected to an HP-GL compatible plotter via its GPIB or RS-232-C interface, colored waveforms, etc. can be plotted. Up to 12 pen colors can be used, and A5, A4 and A3 paper sizes.
(HP-GL: Hewlett-Packard Graphics Language)

HP-GL compatible plotters

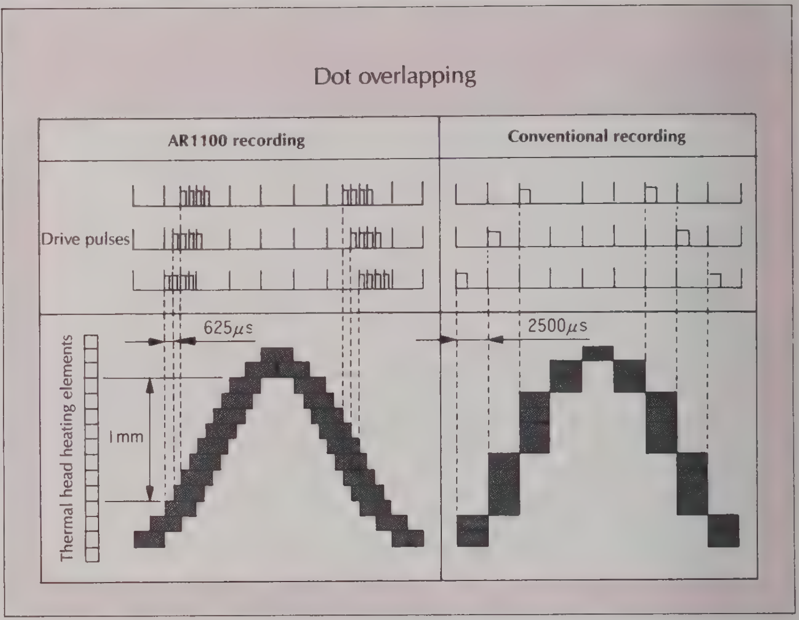
| | |
|---|---|
| Hewlett-Packard: | 7475A, 7550A |
| Epson: | HI-80 |
| Hitachi: | 672-XD |
| Roland: | DXY-990 |



# New technologies used in the AR1100

## Thermal printing technology for high-quality recording

The AR1100 incorporates a thermal printer which uses a thermal head to print a hard copy on heat-sensitive recording paper. The thermal head has a linear array of thin-film thermal elements, and a recording density of 8 dots/mm in the amplitude direction. In conventional thermal printing systems, if the recording density in the amplitude direction is 8 dots/mm, resolution in the time axis direction (direction of paper movement) will also be 8 dots/mm, making the recorded waveform less smooth which is less than ideal for inclusion in a report, etc. The AR1100 uses unique YOKOGAWA Dot Overlap Technique to increase resolution by a factor of four in the time axis direction. As a result, in the recorder mode the AR1100 has a resolution in the time axis direction of 32 dots/mm for the printing of smooth waveforms. Further, by combining Dot Overlapping with heat history control of thermal elements we have achieved an unprecedentedly high resolution.

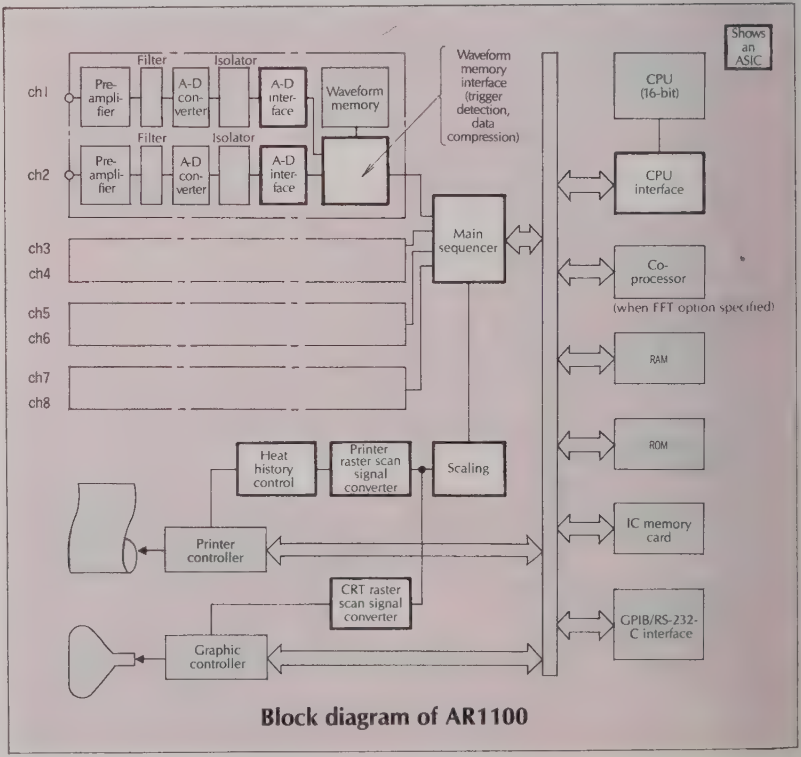


Dot overlapping

## ASIC technology speeds up the path from measurement to printing

The AR1100 incorporates eight ASIC* chips (with a total of about 60,000 gates) developed especially to speed up operation from measurement to printing.

For example, in the memory mode, measured data is stored in waveform memory at the specified sampling speed. If programmed computations are required, the measured data is transferred via a CPU interface, processed by a 16-bit microcomputer, and then is stored in the waveform memory computed data area. In order to display the waveform data on the 640 × 400 dot CRT screen, the waveform data is compressed in the time axis direction, scaled in the amplitude direction, and finally converted to a raster scanning signal to be displayed. When a waveform is to be printed out, the data is compressed, scaled, and raster-scan converted, and heat history control is also applied. To achieve high speed in the entire path from measurement through analysis, display and printing out, every process that could affect speed including sequencing, data compression, scaling, raster-scan signal conversion, and heat history control functions are incorporated in hardware, ASICs specially designed by YOKOGAWA.

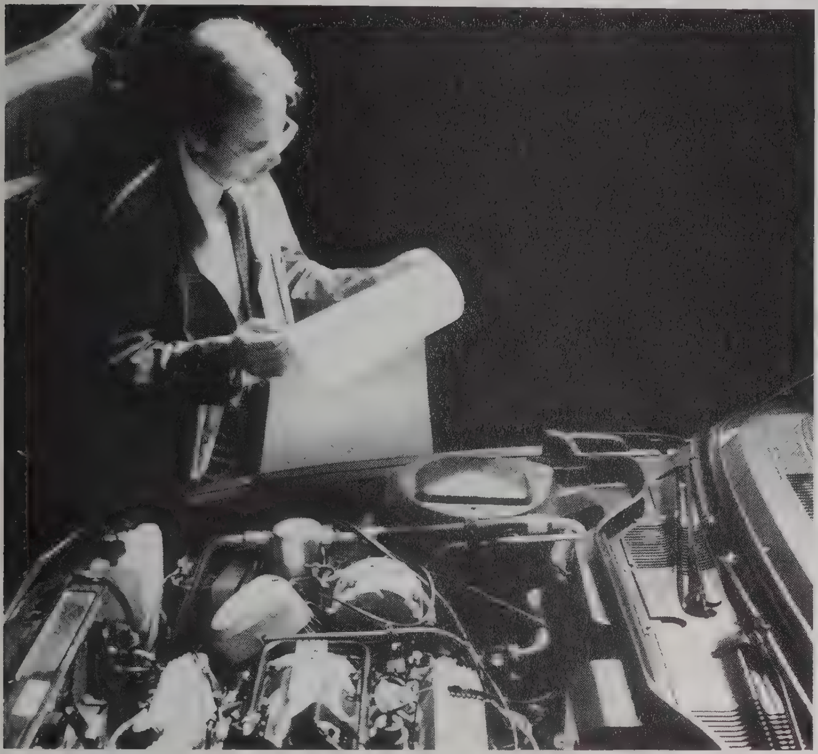


Block diagram of AR1100

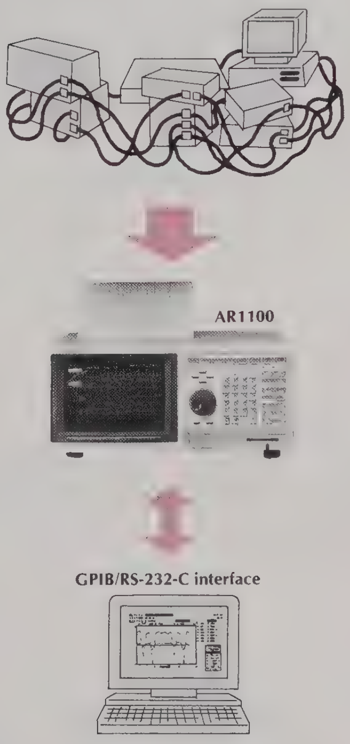
* ASIC is short for "Application-Specific Integrated Circuit", a type of customized IC.

# *Improved productivity wherever it's used*

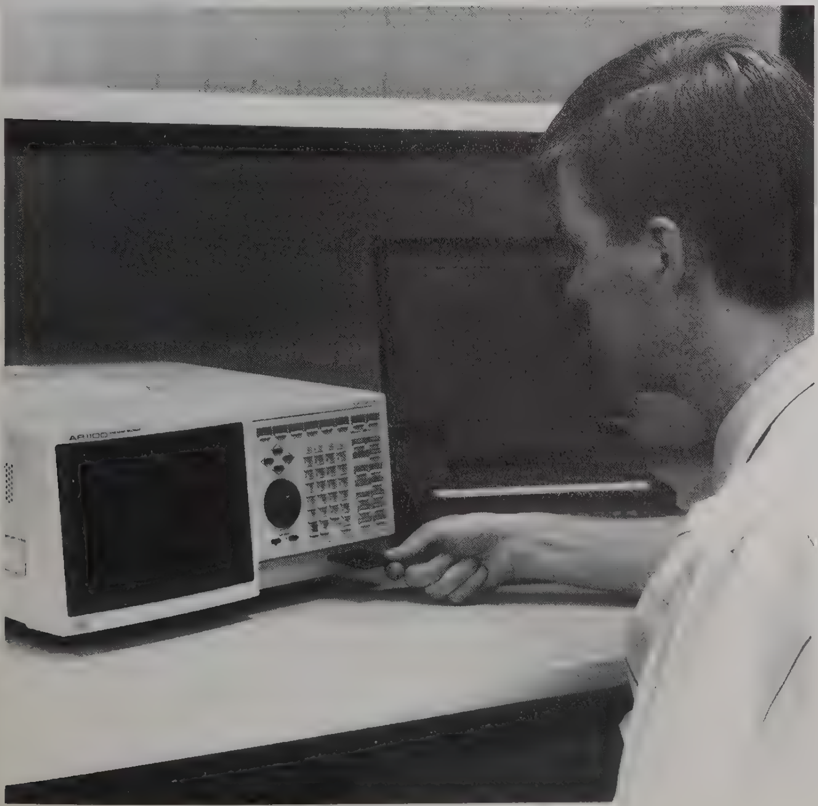
## All-in-One design, convenient for use on the factory floor



The AR1100 is an all-in-one waveform measuring instrument with everything required for measurement through printing out in a single compact unit. This single unit gives the engineer everything needed for use anywhere. In the past, for field testing, engineers had to take a number of instruments. With the AR1100, things have changed; a single unit performs measurement, processing, display, and gives you a print-out of the results. This print-out can then be used as it is in test report or presentation. Because of its compact size, the AR1100 can be taken anywhere. And, unlike a system using a personal computer, it is easy to use without the need to write special software.

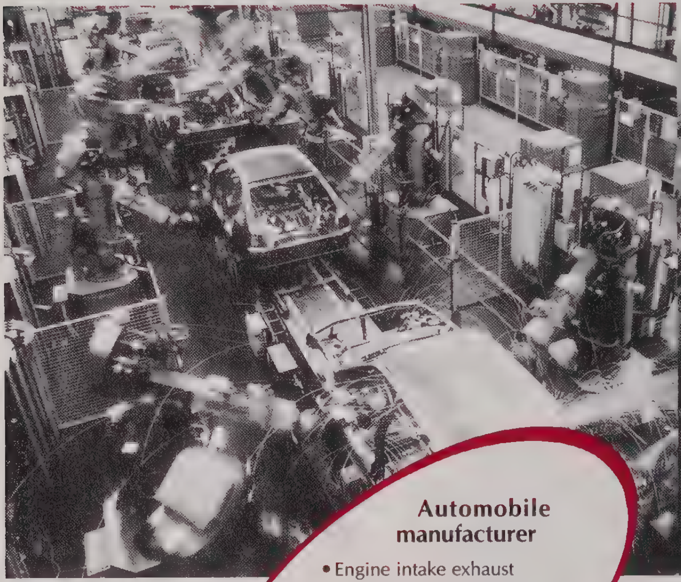


## Designed for use with a personal computer in a laboratory



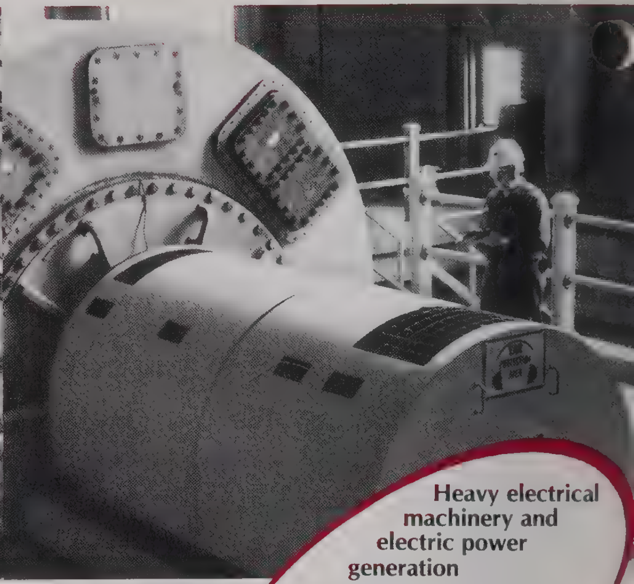
While the emphasis is on the AR1100 as an all-in-one measuring instrument, it is also possible to connect to a computer. Its GPIB or RS-232-C communications functions can be used for remote control of all the AR1100's functions from a personal computer, while waveform and computed data can be transferred from the AR1100 to a personal computer for further analysis. With the AR1100 combined in a system with a personal computer, even more sophisticated analyses can be performed.

# The AR1100 used in a wide range of applications



### Automobile manufacturer

- Engine intake exhaust pressure measurement
- Brake performance tests
- Gear-shift operability tests
- Tire vibration transmission characteristic tests
- Automobile operating data analysis



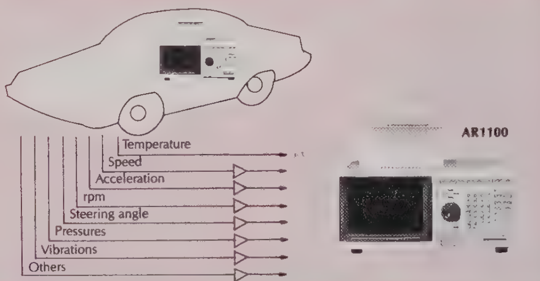
### Heavy electrical machinery and electric power generation

- Motor starting torque and efficiency tests
- Generator short-circuit tests
- Circuit breaker short-circuit tests
- Diagnosis of rotating machinery problems
- Compressor starting characteristic tests

### Automobile running test data analysis

- High-speed simultaneous measurement
- Pretrigger
- Computing functions

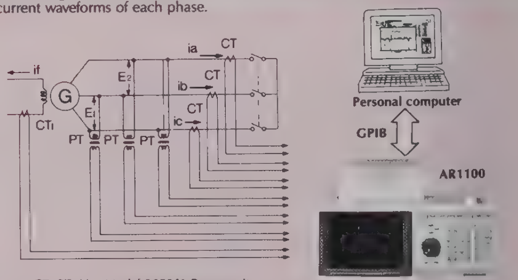
Measurement of speed, acceleration, engine rpm, steering angle, intake and exhaust pressures, temperature, etc. for running vehicles



### Generator short circuit tests

- High-speed simultaneous measurement
- Pretrigger
- GPIB

Examines generator characteristics by measurement and analysis of voltage and current waveforms of each phase.

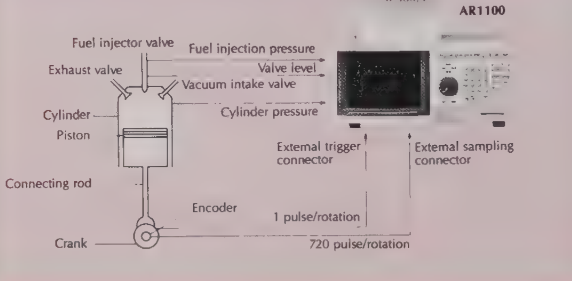


CT, PT: Use Model 365961 Power unit

### Engine performance tests

- High-speed simultaneous measurement
- EXT trigger/EXT sampling
- Averaging function

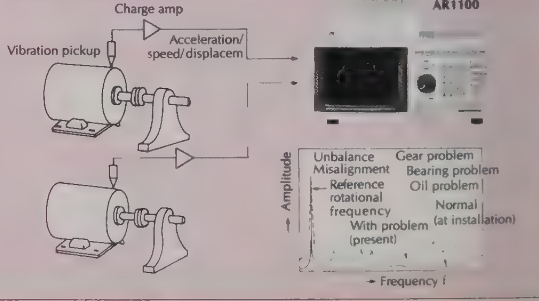
Measures cylinder pressure, fuel injection pressure, and valve open/close levels with respect to crankshaft angle. Uses external triggering and externally-controlled sampling to measure data relative to the crankshaft angle.

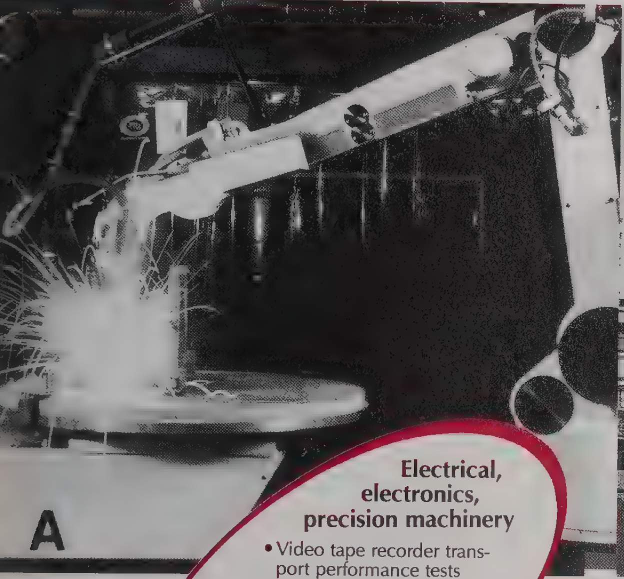


### Diagnosis of rotating machinery problems

- FFT mode
- Frequency [illegible]
- Averaging function

Diagnosis of problems in large rotating machines such as motors and generators using the AR1100's FFT functions.





## Electrical, electronics, precision machinery

- Video tape recorder transport performance tests
- Printer misprint detection monitoring
- Copier drum performance tests
- Optical disk pickup measurement
- Industrial robot performance tests

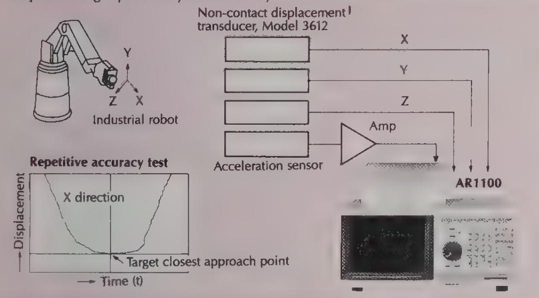
## Machinery, processing plants

- Press parameter tests
- Injection molding performance tests
- Hydraulic elevator performance tests
- Control valve characteristic tests
- Plant maintenance

### Industrial robot performance tests

- High-speed simultaneous measurement
- Sequential memory
- Pretrigger

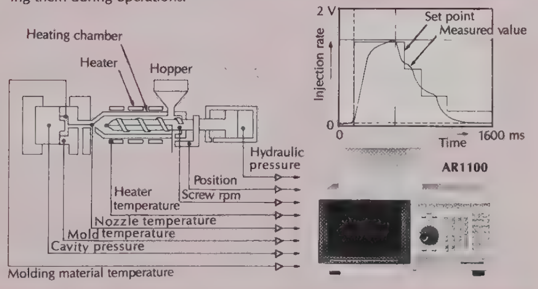
Simultaneously measures position changes in the X, Y, and Z directions to test the positioning repeatability and accuracy of robots.



### Injection molding testing and operation evaluation

- Simultaneous measurement
- Temperature measurement
- Sequential memory

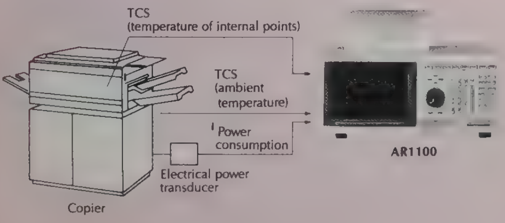
The AR1100 is the best tool for testing injection molding machines and evaluating them during operations.



### Electronic copy machine temperature distribution measurement

- Recorder mode
- Temperature measurement
- Continuous recording

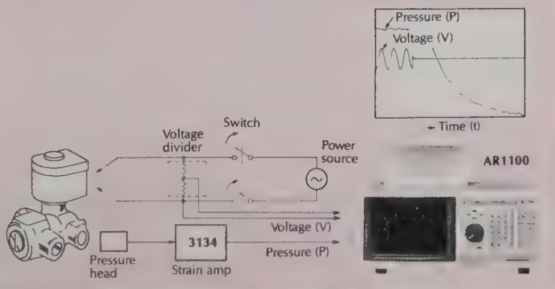
Simultaneously measures and prints out temperature, power consumption, etc. for individual points inside a copier during operation


TCS (temperature of internal points)
TCS (ambient temperature)
Power consumption
Electrical power transducer
Copier
AR1100

### Solenoid valve dynamic performance testing

- High-speed simultaneous measurement
- Cursor/zoom functions
- Scaling

Measurement and analysis of pressure transient response when the power supply to a solenoid valve is switched off for product evaluation.



# Specifications

## Analog input section

### • General

Number of input channels : 4 (**70213□**), 6 (**70215□**), 8 (**70217□**)
Input type : Isolated floating unbalanced input (each channel)
Maximum input voltage : 130 V (DC + AC peak, 1 kHz or less)
Maximum common mode voltage : 250 V AC
Temperature coefficients
Zero point : Auto-calibration before measurement
After auto-cal. { 0.02% of F.S./°C (anti-aliasing filter OFF)
0.04% of F.S./°C (anti-aliasing filter ON)
Gain : 0.01%/°C (immediately after auto-calibration)
After auto-cal. { 0.01%/°C (anti-aliasing filter OFF)
0.05%/°C (anti-aliasing filter ON)
Allowable signal source impedance : 500 Ω, max.

### • Voltage input

Measurement ranges : ±60, 200, 600 mV, 2, 6, 20, 60 V F.S.
Input impedance : Approx. 1 MΩ (with approx. 22 pF capacitor connected in parallel)
Input bias current : 2 nA (typical)
Frequency bandwidth (with filter OFF) : DC to 40 kHz ($^{+1}_{-3}$ dB typical DC coupled)
1 Hz to 40 kHz ($^{+1}_{-3}$ dB typical AC coupled)
Input coupling : DC or AC
Accuracy : ±(0.25% of F.S. +50 μV) (With filter OFF, DC, 23 ±3 °)
Noise : 120 μVp-p (typical) at 60 mV range, input shorted

### • Temperature input (excluding FFT mode)

Frequency bandwidth (with filter OFF) : DC to 6 Hz ($^{+1}_{-3}$ dB, typical)

Measurement range and accuracy (with line filter ON, excluding reference junction compensation accuracy)

| TC type | Measurement range | Accuracy (at 23 to 3 °C) |
|---|---|---|
| **K**<br>**E**<br>**J**<br>**T**<br>**U**<br>**L**<br>**N** | −200 to 1370°C<br>−200 to 800 °C<br>−200 to 1100 °C<br>−200 to 400 °C<br>−200 to 400 °C<br>−200 to 900 °C<br>0 to 1300 °C | ±(0.2% of rdg +1.5 °C)<br>Except −200 to 0 °C: ±(0.5% of rdg +1.5 °C) |
| **R**<br>**S** | 0 to 1760 °C<br>0 to 1760 °C | ±(0.2% of rdg +2°C)<br>Except 0 to 200 °C: ±6 °C, 200 to 800 °C: ±4 °C |
| **B** | 0 to 1820 °C* | ±(0.2% of rdg +4°C)<br>Except 400 to 700 °C: ±8 °C |
| **W** | 0 to 2315 °C | ±(0.2% of rdg +3°C) |

* Effective measurement range is 400 to 1820 °C.

Reference junction compensation accuracy : ±0.8 °C (with stable input terminal temperature), ±1.5 °C (R, S, B)

### • Filters

Selectable filters : Line filter (LIN), low pass filter (LPF), anti-aliasing filter (AUTO), OFF (only OFF and LIN can be selected in the temperature input mode)
Cut-off frequency (−3 dB, typical):
Line filter : 1.5 Hz
Low pass filter : 40, 400 Hz, 4 kHz, OFF
Anti-aliasing filter : 40, 80, 200, 400, 800 Hz, 2, 4, 8, 20, 40 kHz
Cut-off characteristics (typical):
Line filter :
Normal mode rejection ratio; −50 dB/50 or 60 Hz
Common mode rejection ratio; −120 dB/50 or 60 Hz
Low pass filter : 24 dB/oct
Anti-aliasing filter : −72 dB/1.5 fc (fc: cutoff frequency)

Passband characteristics (typical):
Anti-aliasing filter : ±0.5 dB (DC to ½ fc), except 40, 400 Hz, 4, 40 kHz $^{+0}_{-1.5}$ dB (¼ fc to ½ fc)

Modes and filters:

| Filter | Memory mode | Recorder mode | FFT mode |
|---|---|---|---|
| **LINE** | ○ | ○ | − |
| **LPF** | ○ | ○ | − |
| **AUTO** | ○ | (=OFF) | ○ |
| **OFF** | ○ | ○ | ○ |

(LINE: Line filter, LPF: Low pass filter, AUTO: Anti-aliasing filter)

Automatic filter selection : When AUTO is selected, the anti-aliasing filter (cut-off frequency = sampling rate/2.5) is selected automatically

### • A-D converters (independent for each channel)

Resolution : 14 bits
Conversion speed : 10 μs (100 kS/s)
Measurement method : Simultaneous measurement on all channels

## Memory mode

### • Memory section

Maximum memory capacity : 64k words/channel (**7021□1**)
512k words/channel (**7021□4**)
Memory elements : DRAMs (volatile memory)
Memory methods : Selectable between standard, coupled and partitioned
Standard : Up to the maximum memory capacity of each channel can be specified for writing
Coupled : Even-channel memories are coupled to odd-channel memories for writing; the number of usable channels is halved, and programmable processing, averaging and specifying memory partitioning cannot be performed
Partitioned : Each channel memory is divided to blocks and writing is done to each block at every triggers; averaging cannot be performed
Number of memory partitions : 4, 8, 16, 32, 64, 128 blocks, selectable; maximum number of blocks determined by maximum memory capacity and programmable processing
Maximum data capacity per channel : (k=1,000 words/channel)
Standard : W/o averaging and programmable processing; 64k (**7021□1**), 500k (**7021□4**)
W/o averaging, with programmable processing; 16k (**7021□1**), 125k (**7021□4**)
With averaging, w/o programmable processing; 16k (**7021□1**), 125k (**7021□4**)
With averaging and programmable processing; 8k (**7021□1**), 64k (**7021□4**)
Coupled memory : 125k (**7021□1**), 1,000k (**7021□4**)
Memory partitioning:

| Maximum Memory Capacity | Programmable Processing Specified | Number of Memory Partitions | | | | | |
|---|---|---|---|---|---|---|---|
| | | 4 | 8 | 16 | 32 | 64 | 128 |
| | | Maximum data capacity per channel (k words/ch) | | | | | |
| **64k (7021□1)** | No | 16 | 8 | 4 | 2 | 1 | × |
| | Yes | 4 | 2 | 1 | × | × | × |
| **512k (7021□4)** | No | 125 | 64 | 32 | 16 | 8 | 4 |
| | Yes | 32 | 16 | 8 | 4 | 2 | 1 |

Writing speed : 10, 20, 50, 100, 200, 500 μs, 1, 2, 5, 10, 20, 50, 100, 200, 500 ms, 1, 2, 5, 10 s per word and external sampling clock (EXT SAMPLE, 100 kHz max.)
Time axis accuracy : ±0.02%

### • Triggering

Start/stop : Three methods to start and stop measurement can be selected

(1) Start/Stop key operation on the front panel

(2) External START/STOP signal (TTL level, one point, LOW to start)

(3) GPIB or RS-232-C commands

Trigger modes : FREE, SINGLE, REPEAT (selectable)

FREE : Measurement starts with START and stops with STOP (measurement is done regardless of whether the trigger condition is satisfied)

REPEAT : With START, the trigger stand-by mode is engaged. After that, each time the trigger condition is satisfied, writing is done to the entire memory; with STOP, the trigger stand-by mode is released. However, if the memory is partitioned, the block number is counted up for each trigger and after the last block has been written, the trigger stand-by mode is released.

SINGLE : With START, the trigger stand-by mode is engaged. When the trigger condition is satisfied first, writing is done to the entire memory and the trigger stand-by mode is released immediately. If the memory is partitioned, the block number is counted up after writing and the stop mode is engaged.

Trigger sources : Internal (INT), external (EXT), selectable

Internal trigger : Combination trigger

Triggering system; digital trigger using data measured on each channel

Trigger source; four source channels can be specified

Selectable trigger combinations;

AND or OR, selectable: trigger with AND or OR of all sources: after specifying the same channel for two sources, bi-slope and window triggering are possible

Trigger ON/OFF; ON/OFF can be specified for each source: with OFF=don't care

Trigger level; −100% to +100%, set resolution of 1%

Trigger slope; rising or falling edge, selectable

Trigger status; high or low, selectable: with HIGH, trigger is effective over the trigger level: with LOW, trigger is effective under the trigger level

External trigger : Trigger with TRIG IN signal (TTL level):

External trigger slope specified; select from rising or falling edge

Pretrigger : Possible to be set for external and internal triggers

Setting range : 0 to 100%, possible to be set in 10% steps

### • Analytical processing

Linear scaling : After setting the offset value and scale factor value for the setting value of each channel, scaling is done for each data acquisition and the obtained data is used as the measured data

Averaging : Selectable among OFF, simple averaging and exponential averaging

Number of times (attenuation constant) : Select from 4, 8, 16, 32, 64, 128, 256

Programmable processing : Possible to define the computation formula from a combination of functions

Number of formulae : Up to 8, the same as the number of input channels

Number of characters in formula : 55 characters, max.

Operators : +, −, ×, ÷, [(, )]

Variables : Measured data from each channel and data from IC memory card (4 channels)

Constants : 20, max.

Functions : SQR (square root), LOG (logarithm), EXP (exponent), ABS (absolute value), DIF (differentiation), DDIF (double differentiation), INTG (integration), IINTG (double integration), MEAN (10 to 128 point moving average), SIN, COS, TAN, ASIN, ACOS, ATAN (averaging, differentiation and integration can be executed only once in a formula.)

Zone statistical computation : The zone of the waveform on the screen specified with the two cursors is processed and displayed

Types of zone statistical computations : Area (area between waveform and cursors, or enclosed by a waveform, for T-Y and X-Y waveforms), maximum value, minimum value, P-P value, average, RMS value, standard deviation (between cursors)

Waveform judgment : Judgment is done for one specified channel

Judgement area definition : Done by moving displayed waveform up, down, left and right. Averaged and processed waveforms can be used.

Judgement actions : Auto save or automatic recording (selectable)

Auto save : Only GO waveforms or NO GO waveforms are stored into sequential memory

Automatic recording : Only GO waveforms or NO GO waveforms are recorded

GO/NO GO output : Outputs GO/NO GO signals (TTL level)

### • Display functions

Display format :

SINGLE display : 1 to 8 channels dispslayed on one screen

DUAL display : 1 to 4 channels displayed on each of two subscreens

QUAD display : 1 channel displayed on each of four sub-screens

X-Y display : 4 channels displayed

Cursor : Digital display of data at the selected point

Reference cursor : Differences between cursor and reference cursor displayed

Scroll :

Vertical direction : Scrolls only waveform specified by cursor

Horizontal direction : Scrolls all waveforms on the same screen

Zoom :

Vertical direction : Magnifies waveform specified by cursor; with X-Y display, both X and Y axes are magnified

Horizontal direction : Magnifies all waveforms being displayed

Grid display : ON/OFF possible

Display scale : Scales display along vertical axis (upper limit, lower limit)

Superimposed display : Newly-measured waveform is superimposed over waveform stored in memory

Others : Moving display between blocks, program start

### • Printing

Size : A5 (screen hard-copy), A4, or required data length (analog, digital recording)

Mode : (1) Screen hard-copy Recording resolution; 640 × 400 (same as CRT display)

(2) Plotting of CRT screen
Recording density; 8 dots/mm

(3) Analog recording of data in specified range
Recording density; 8 dots/mm
Time-axis waveform recording resolution; 20 dots/mm

(4) Digital recording of data in specific range

(5) Setup list printing; Prints setup information

Title : Titles can be printed at top of hard copy, etc. (up to 40 characters)
Available characters; alphanumerics, parentheses, +, −, ×, ÷

Automatic printing start function : Recording at trigger or at GO/NO GO judgment

## Recorder mode

### • Recording

Recording format selection : Analog trend or digital trend, selectable
Analog trend : Waveform recorded on the continuous chart
Recordable data : Measured data of each channel
Number of recording channels : 8 max.
Scaling : Linear scaling possible for each channel
Sampling interval : Voltage range; 10 µs (100 kS/s):
Temperature range; approx. 7.4 ms (135 Hz)
Recording method : Recording possible filling the zone between the maximum and minimum values of measurement samples with the recording density of the thermal printer
Effective recording width : 200 mm
Recording paper length : Chart length of 50 m
Recording paper speed : 10, 20, 50 mm/h, 1, 2, 5, 10, 20, 50 mm/min, 1, 2, 5, 10, 20, 50 mm/s
Recording color : Black
Recording density : 8 dots/mm
Time-axis waveform recording resolution : 32 dots/mm
Recording accuracy : Measurement accuracy ±0.125 mm (1 dot)
Digital trend : Listing of digital values of waveform data, the interval to be selected from 1, 2, 5, 10, 20, 30 and 60 s

### • Trigger

Time trigger : Specifies the recording start and stop date and time (month/day/hour/minute)
Fixed time recording : Starts and stops recording at the specified time (hour/minute) every day

### • Display functions

Display format : Roll mode
Number of displayed waveforms : 8, max.
Display time range setting : 0.5, 1, 2.5, 5, 10, 25, 50, 100, 250 s, selectable
Display update cycle : 1/500 of the display time range

## FFT mode (option)

### • Trigger : Same as memory mode

### • Analysis and display

Number of channels : 2 channels
Channel select : Waveform data of the specified input channel or that written to IC card collected in the memory mode
Engineering unit : Converts input voltage from external transducer to technical units
Analysis functions : Linear spectrum, power spectrum, power spectrum density, over-all, RMS spectrum, cross spectrum, transfer function, coherence function
Frequency :
Frequency ranges : 4, 8, 20, 40, 80, 200, 400, 800 Hz, 2, 4, 8, 20, 40 kHz
Frequency resolution : 1/400 of the frequency range
Window : Hanning or rectangular
Dynamic range : 72 dB (typical)
Sampling :
Sampling frequency : 2.5 times the frequency range
Frequency accuracy : ±0.02%
Number of sampling points : 1,000 points
Anti-aliasing filter : ON or OFF, selectable; when ON, the cut-off frequency is interlocked with the frequency range at 40 Hz to 4 kHz (2-4-8 sequence) and automatic setting (set to 40 H for the frequency range of 4, 8, 20 Hz) is done
Distortion : 0.5% F.S. (less than the input at 10 kHz), 2% of F.S. (more than the input of 10 kHz), with anti-aliasing filter ON and F.S. input)

Averaging :
Time-axis averaging : OFF, simple average, exponential average
Frequency-axis averaging : OFF, simple average, exponential average, peak hold; with peak hold, frequency analysis is performed several times and the maximum value is displayed
Number of times (attenuation constant) : Select from 4, 8, 16, 32, 64, 128, 256
Display format : Single display; 1 analysis result display
Dual display; 2 analysis result display
Time-axis waveform simultaneous display possible
Nyquist display
Array display; Analysis result of 16 time series is displayed
Cursor : Reading of the frequency and analyzed value
Reference cursor : Reading of the difference in the frequency and analysis value between two points

### • Recording

Size : A5 (for screen hard-copy), A4
Mode : (1) Screen hard-copy Recording resolution; 640 × 400 (same as CRT display)
(2) Plotting of screen
Recording density; 8 dots/mm
(3) Setup list printing
Title : Same as in memory mode

## General specifications

### • CRT display : 9-inch CRT (display color: amber), 640 × 400 dots, 4 levels

### • Recording

Recording system : Thermal printer
Effective width : 200 mm
Recording density : 8 dots/mm
Time-axis waveform resolution : 20 dots/mm (memory mode, analog recording), 32 dots/mm (recorder mode, analog trend)
Recording speed : 50 mm/s max. (recorder mode), 20 mm/s (hard copy, etc.)

### • External input/output signals

TRIG IN : TTL level ↑ or ↓ (pulse width of 2 µs or more)
TRIG OUT : TTL level ↑⎿ (pulse width of 3 µs or more) for parallel operation
EXT SAMPLE : TTL level ↑⎿ 100 kHz max. (pulse width of 2 µs or more)
START/STOP : TTL level ↓ START, ↑ STOP
GO/NO GO : TTL level ↓⎾ (pulse width or 100 ms or more)

### • Others

Clock accuracy : ±50 ppm (typical)
Setting value memory : One set of front panel settings is stored in memory
Battery backup : Setting value memory and clock backed up by lithium battery with life of approx. 10 years (at room temperature)
Operating environment : 0 to 40 °C, 30 to 80% RH (noncondensing), except 5 to 35 °C for printer operation
Dielectric strength : Between power supply and case; 1,500 V AC for 1 minute
Between input terminals and case;1,500 V AC for 1 minute
Insulation resistance : Between power supply and case; 10 MΩ or more at 500 V DC
Between input terminals and case; 10 MΩ or more at 500 V DC
Power requirements : 90 to 132 V/180 to 250 V AC (automatic switching), 48 to 63 Hz

| | |
|---|---|
| Power consumption | |
| When printer is not operating | With 90 to 132 V AC, approx. 120 VA (**70213□**), approx. 135 VA (**70215□**), approx. 150 VA (**70217□**)<br>With 180 to 250 V AC, approx. 200 VA (**70213□**), approx. 225 VA (**70215□**), approx. 250 VA (**70217□**) |
| When printer is operating | With 90 to 132 V AC, 500 VA max., with 180 to 250 V AC, 700 VA max. |
| Dimensions | Approx. 177 (H) × 426 (W) × 410 (D) mm (7″ × 16¾″ × 16⅛″) |
| Weight | Approx. 13.5 kg (29.8 lbs.) (**70213□**), approx. 14 kg (31 lbs.) (**70215□**), approx. 14.5 kg (32 lbs.) (**70217□**) |

### • Accessories supplied at no extra cost

Roll chart (1 pc., 210 × 50 mm thermal paper), Power cord (1 pc.), Fuse (1 pc., 3.15 A), chart holder (1 set), Instruction Manual (1 set)

## Options and optional accessories

### • GPIB interface (Optional/GP-IB)

| | |
|---|---|
| Standard | Conforms to IEEE Standard 488-1978 |
| Functional specifications | SH1, AH1, T5, L4, SR1, RL1, PP0, DC1, DT0, C0 |
| GPIB functions | Setting value input/output, measured value output (setting and control excluding power ON/OFF), HP-GL plotter output |

### • RS-232-C interface (Optional/RS232C)

| | |
|---|---|
| Standard | Conforms to EIA RS-232-C |
| Transmission rate | 75, 150, 300, 600, 1200, 2400, 4800, 9600 bps |
| RS-232-C functions | Setting value input/output, measured data output (setting and control excluding power ON/OFF), HP-GL plotter output |

### • HP-GL plotter output (common to the GPIB and RS-232-C interfaces)

| | |
|---|---|
| Applicable models | HP ; 7475A, 7550A<br>EPSON ; HI-80<br>Hitachi ; 672-XD<br>Roland ; DXY-990 |
| Plot output | Plotting in the memory mode and FFT mode |

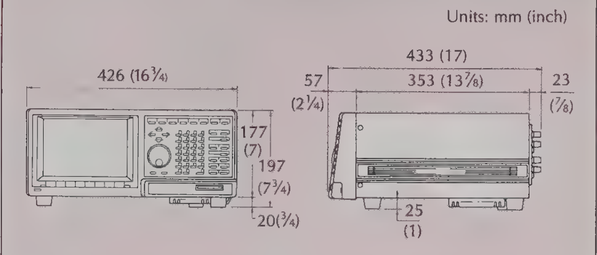
### • IC memory card (Optional accessory)

| | |
|---|---|
| Card slot | 1 slot provided as standard |
| Memory capacity | 512 Kbytes, 256 Kbytes, 64 Kbytes<br>2 bytes/word (measurement data) |
| Memory data | Specified part of waveform memory |
| Panel setting information | File size required for 1 setting is approx. 1.5 kbytes |
| Data readout display | Waveforms can be displayed on screen when data is read from IC memory card to waveform memory |
| Battery | Lithium battery (life: approx. 3 years for 64 Kbytes, approx. 2 years for 256 Kbytes, approx. 1 year for 512 Kbytes) |

### • Power unit 365961 (Optional accessory)

| | |
|---|---|
| Input system | PT isolated floating system (voltage), CT isolated floating system (current) |
| Number of input channels | 2 (voltage), 2 (current) |
| Rated input | 100, 150, 300, 600 V (voltage), 1, 2, 5, 10 A (current) |
| Output voltage | 1.0 V at the rated input |
| Accuracy | 0.2% of range |
| Operating frequency range | 50 to 60 Hz, 2 kHz max. for harmonic content (amplitude flatness is within ±0.5% up to 2 kHz) |
| Dielectric strength between channels | 1,000 Vrms |

## ■ DIMENSIONS



## ■ AVAILABLE MODELS

| Model | | Suffix Codes | | | Description |
|---|---|---|---|---|---|
| 7021 | | | | | Analyzing recorder AR1100 |
| Input Channels & Memory Capacity | 31 | | | | 4 channels (64k words/channel) |
| | 34 | | | | 4 channels (512k words/channel) |
| | 51 | | | | 6 channels (64k words/channel) |
| | 54 | | | | 6 channesl (512k words/channel) |
| | 71 | | | | 8 channels (64k words/channel) |
| | 74 | | | | 8 channels (512k words/channel) |
| Power Requirements | | −0 | | | 90 to 132 V AC, 180 to 250 V AC (automatic switching) |
| Power Cord | | | /D | | UL standard |
| | | | /F | | VDE standard |
| | | | /H | | SAA standard |
| | | | /J | | BS standard |
| | | | /M | | JIS standard |
| Optional Feature | | | | /FFT | FFT function |
| | | | | /RS232C | RS-232-C interface |
| | | | | /GP-IB | GPIB interface |

**Note:** Both GPIB and RS-232-C interface are not compatible with a single instrument.

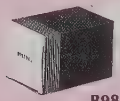
## ■ OPTIONAL ACCESSORIES

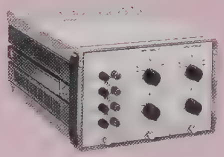
| Name | Code | Description | Order Q'ty |
|---|---|---|---|
| Power unit | **365961** | 2 channels each (V, A) | 1 unit |
| Measurement lead | **B9409LA** | Banana-clip (1 m) | |
| Conversion adapter | **366921** | BNC-Banana | |
| Conversion adapter | **366922** | Banana-BNC | |
| Plug adapter | **366923** | T-shaped | |
| BNC cable | **366924** | BNC-BNC (1 m) | |
| BNC cable | **366925** | BNC-BNC (2 m) | |
| Clip lead | **366926** | BNC-clip (1 m) | |
| IC memory card | **378903** | 64 Kbytes | |
| IC memory card | **378904** | 256 Kbytes | |
| IC memory card | **378905** | 512 Kbytes | |
| Cleaning kit | **700921** | For screen | |

## ■ SPARES

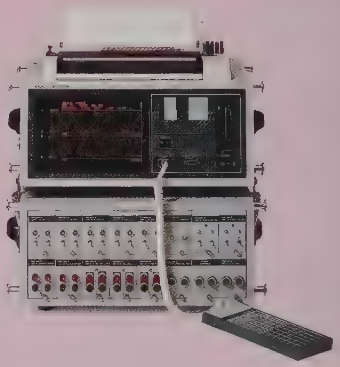
| Name | Part No. | Description | Order Q'ty |
|---|---|---|---|
| Roll chart | **B9879AJ** | 50 m length (1 roll/unit) | 6 units |
| lithium battery | **B9586JU** | For **378903** (1 pc./unit) | 2 units |
| lithium battery | **B9586JV** | For **378904** & **378905** (1 pc./unit) | 2 units |

## OPTIONAL ACCESSORIES & SPARES





## RELATED INSTRUMENTS



**AG1200 Arbitrary waveform generator**
- 4 channels simultaneous output
- 12 bit D-A converter (10 MHz clock, max.)
- Large memory capacity, 32K words/channel
- Analog waveform plus Digital pattern generator

**AR3200 Analyzing recorder**
- 32 channels, max.
- Accepts plug-in voltage, strain, charge, isolation, F-V, and TC input amp
- Total 4-M words, max. large memory capacity
- 4-color internal plotter

YOKOGAWA

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YOKOGAWA

# AR 1600

## Analyzing Recorder

*16-channel analog input*
*in a single compact package*

****REPRESENTED BY:*****
NORTHERN TECHNICAL SALES
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LIVERPOOL, N.Y. 13088
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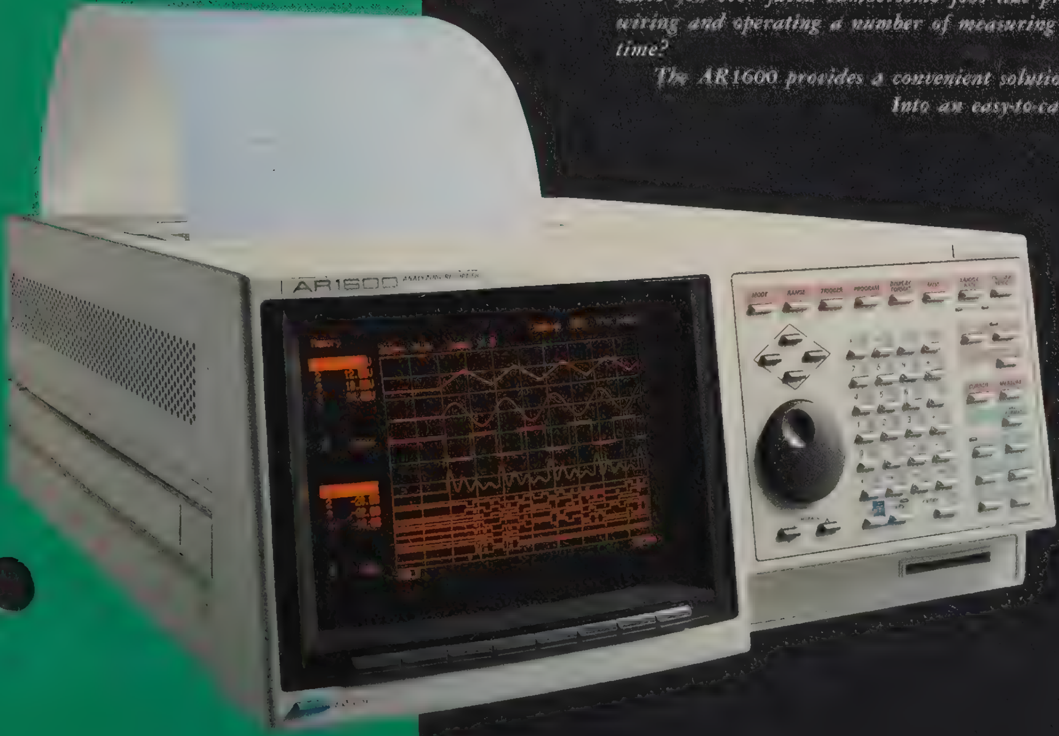
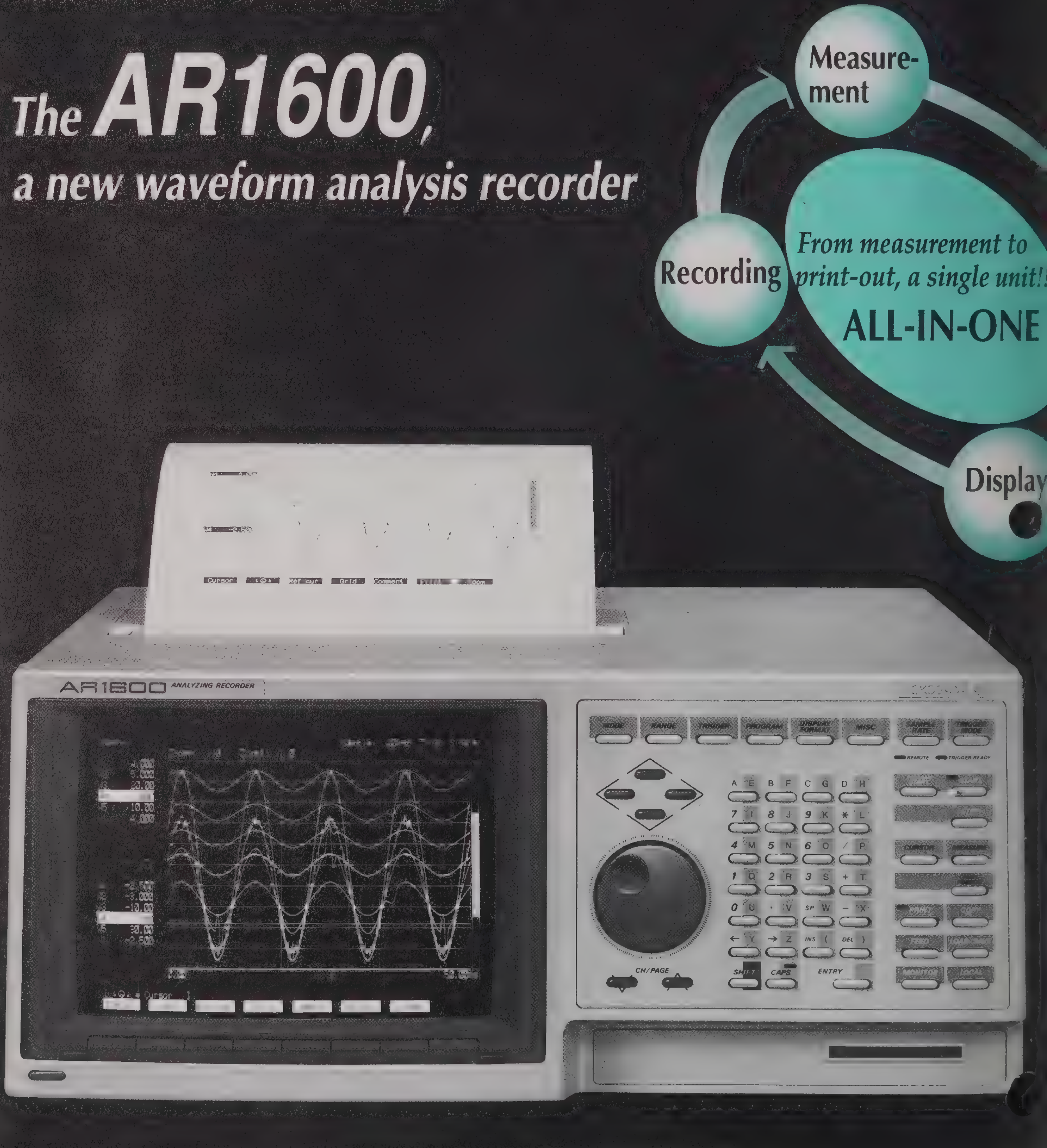
*In the field or lab, your engineering productivity can be greatly increased by using an entirely new, powerful waveform measuring instrument; YOKOGAWA'S AR1600 Analyzing Recorder.*
*Have you ever faced cumbersome jobs like preparing, installing, wiring and operating a number of measuring instruments at one time?*

*The AR1600 provides a convenient solution to such problems. Into an easy-to-carry, single package, the AR1600 consolidates all the functions needed for waveform measurement, including measuring, computing, display and powerful recording functions.*



## 16-channel input
## meeting the needs of engineers for multi-channel measurement

# The AR1600,
## a new waveform analysis recorder



# AR1600

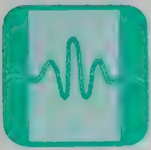
cessing

Voltage, current, pressure and distortion, vibrations and sound..... There's a very real demand for measuring instruments that can measure several analog waveforms at the same time. The AR1600 analyzing recorder is designed to meet this demand and can measure 16 channels simultaneously. With it, the inputs are measured, their values are processed, then their waveforms and the results of processing are displayed and printed out — everything required for waveform measurement and analysis in a single package. A variety of functions are available, including the continuous printing out of phenomena from low- to high-speed over long periods, X-Y display, waveform measurement, various arithmetic operations, and frequency analysis. The compact and versatile AR1600, another YOKOGAWA original.

- 16-channel analog input (non-isolated)
  16-channel logic input (analog 12-channel model)
- Large memory of 256k words/channel
- 3.5-inch FDD (optional)
  *MS-DOS format 2HD and 2DD disks
- DC 12 V power supply (optional)
  Ideal for data collection in automobile testing

* MS-DOS is registered trademark of Microsoft Corporation.

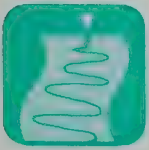
## Three measuring instruments -- a digital memory, a data recorder and an FFT analyzer -- in a single package



### Memory mode

- **For the storage, processing, analysis, display and printing out of high-speed and low-speed phenomena**
- **X-Y display and print-out**

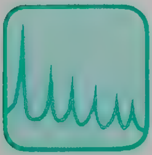
The ability to measure single-shot phenomena over long periods demonstrates the power of the AR1600's memory mode. With its large memory, measurement is possible over long periods without reducing the sampling rate. It can also capture transients which occur before triggering.



### Recorder mode

- **Real-time continuous recording**
- **Data logging**

Up to 8 channels can be printed out at the same time, in real time, on continuous chart paper. Standard chart paper is 210 mm wide and 50 m long. The printing speed can be selected in 15 steps, from 10 mm/hour to 50 mm/sec.

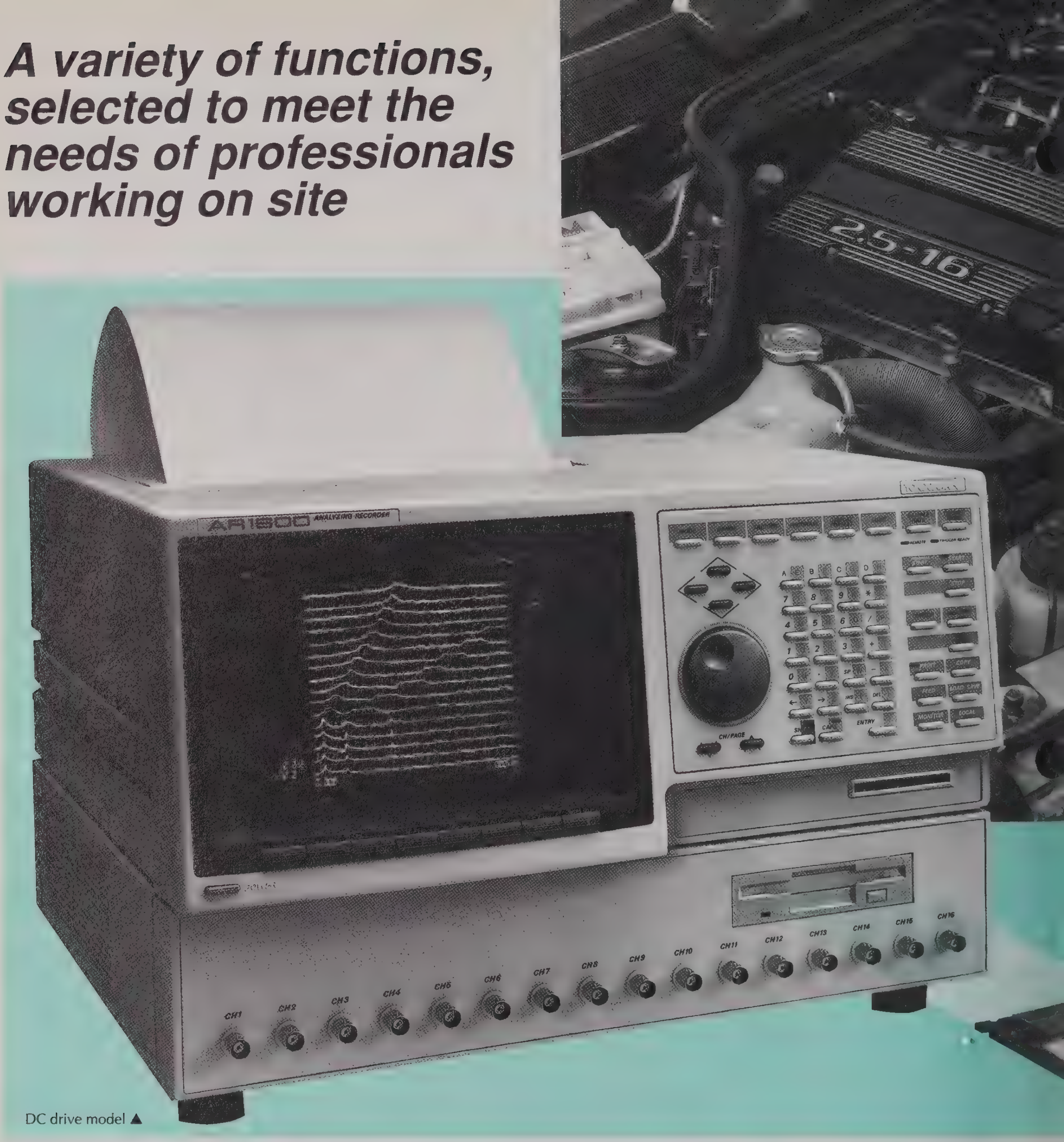


### FFT mode

- **Frequency analysis**
- **Transfer function**

As signal waveforms can be handled in the frequency domain, the characteristics of signals can be observed more precisely. The frequency analysis of any two specified channels from the up to 16-channel inputs can be performed in the frequency range from DC to 20 kHz.

# *A variety of functions, selected to meet the needs of professionals working on site*



DC drive model ▲

With its 16-channel input, the AR1600 is designed for professionals who have to be aware of instantaneous changes in measured values and evaluate a variety of conditions instantaneously.

To meet professional requirements, it incorporates a large 256k words/channel memory, powerful processing functions, a high-speed display and high-speed printing; together with easy operation, compact size and light weight, these add up to an unbeatable combination. All these features are provided to meet the needs of engineers working on site. For professionals who have to know details of instantaneous changes, advanced functions are available with easy operation. Another demonstration of YOKOGAWA's professional experience.

### High-speed display and high-speed recording

The simultaneous display of 128k words of data for each of 8 channels can be achieved within about 1 second. Then an A5 size hard copy of the screen display can be printed out by the built-in printer in 8 seconds.

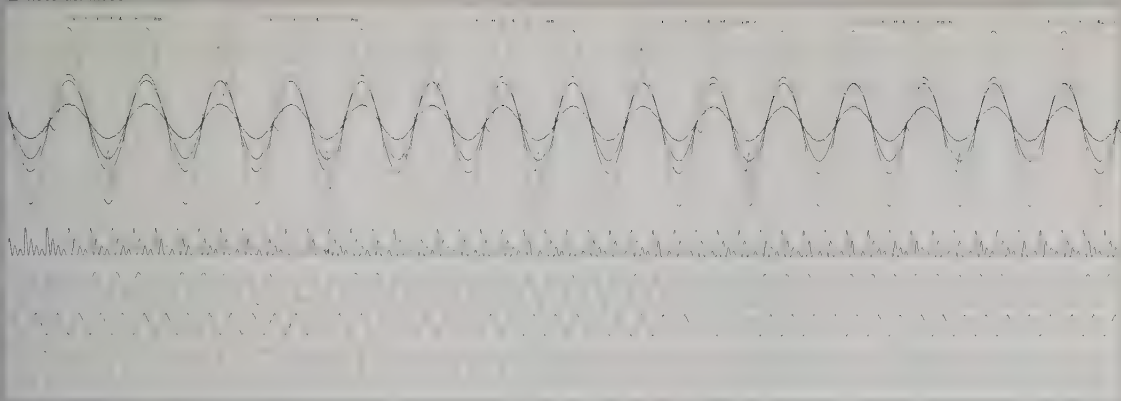
### Variety of processing function

The AR1600's operation functions range from basic arithmetic functions, to differentiation, integration and trigon metric functions, the computation of maximum and mi mum values and areas, and even frequency anal functions.

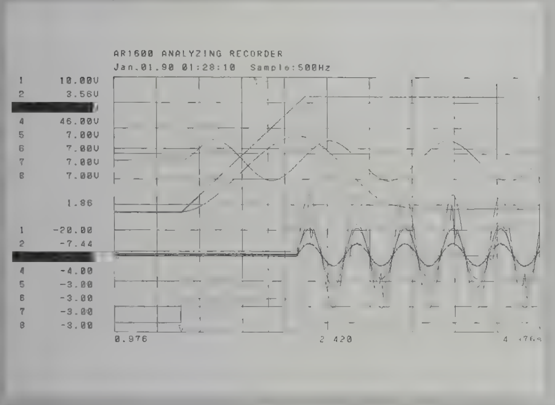
### DC power supply (optional)

As it can operate with a 12 V DC as well as an AC power supply, the AR1600 can be used for measurement and analysis anywhere and everywhere.

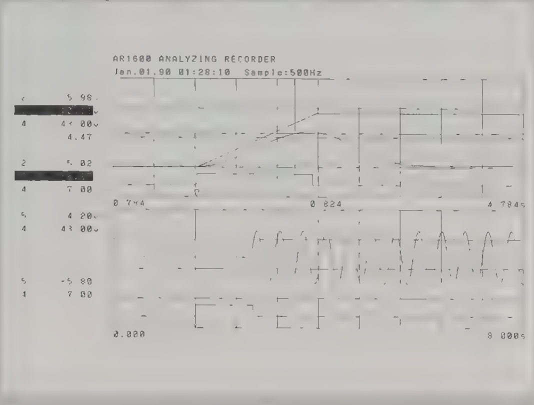
**Recorder mode**



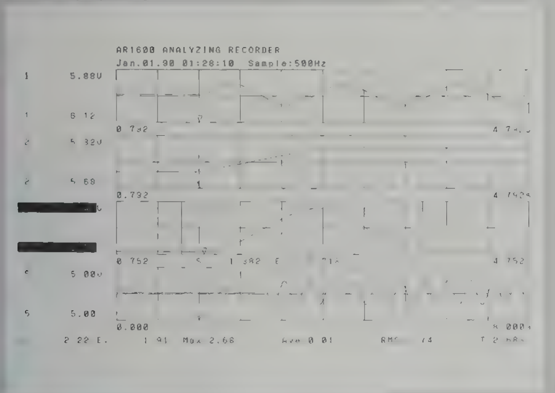
**Single printing**



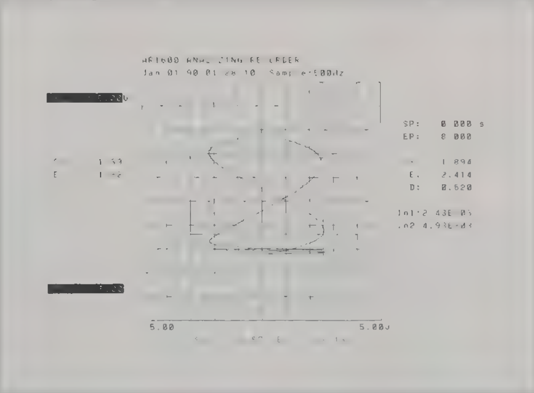
**Dual printing**



**Quadruple printing**



**X-Y plotting**



**Functions selected for the convenience of on-site professionals**

- Large memory capacity (256k words/channel)
- High-speed display and high-speed printing
- Easy operation
- Compact and light (15 kg)

# Storage, analysis, display and printing out of all phenomena, from low to high speed...Memory mode

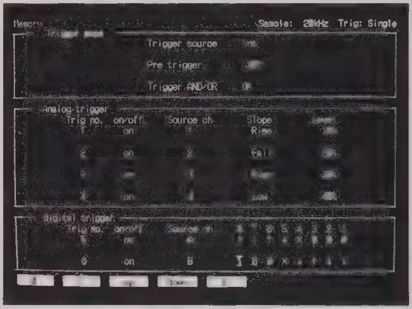
## Measurement and processing

### MEMORY

The maximum memory of 256k words for each channel allows measurement for approx. 70 hours at a 1-Hz sampling rate and for 5 seconds with 50 kHz sampling. When the memory partition function is used, up to 128 phenomena can be saved. With models equipped with SRAM memories, data is not lost when the power is turned off. (Consult your dealer about options.)

### TRIGGER FUNCTION

For analog inputs, up to 4 channels can be triggered; when logic inputs are used, a maximum of 8 channels x 2 can be triggered.
ON/OFF, source channel, level (analog) and trigger slope/status (rise, fall, high level and low level) can be selected for each point. In addition, as AND or OR functions can be set for triggering, even complex phenomena can be captured accurately. This function is useful for relay sequence analysis, the monitoring of abnormalities, and the measurement of characteristics at the start, end and during special operations.

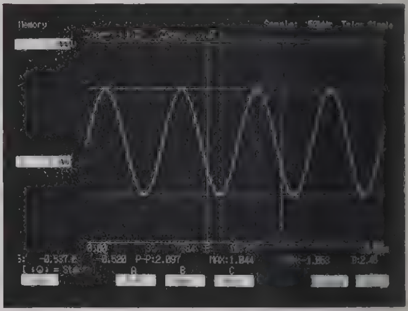


### PROGRAM OPERATION FUNCTIONS

Functions available include basic arithme operations (+, –, x and ÷), square root (SQR), common logarithm (LOG), exponent (EXP), absolute value (ABS), moving average (MEAN), differentiation (DIF), double differentiation (DDIF), integration (INTG), double integration (IINTEG) and trigonometric functions (SIN, COS, TAN, ASIN, ACOS, ATAN). These functions can be combined for the calculation of formulae.

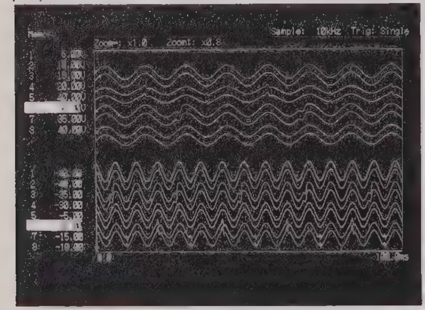
### ZONE STATISTICAL COMPUTATIONS

The maximum (MAX), minimum (MIN), peak-to-peak (P-P), average (AVE), root-mean-square (RMS), standard deviation (SD), and area (INTEG) values can be determined for the zones of the displayed waveform specified by two cursors.



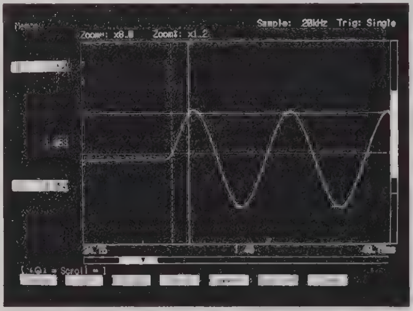
## Display

Single, dual, quadruple and X-Y display formats are available.
In the single mode, up to eight waveforms or 6 analog channels + 16 logical channels can be displayed on the CRT. Display settings are available for two screens and switching between these is a one-touch operation. By using the overwriting function, up to 16 analog waveforms can be displayed.



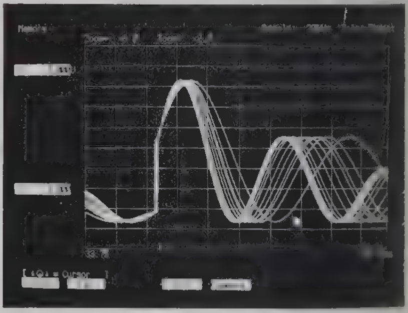
### CURSOR, ZOOM and SCROLL

The cursor speed can be set in 9 steps. Even when the large memory mode is used, the cursor can be moved quickly to the required point. Zoom and scroll functions are provided to access and enlarge the display of the required section of a waveform.



### ACCUMULATE FUNCTION

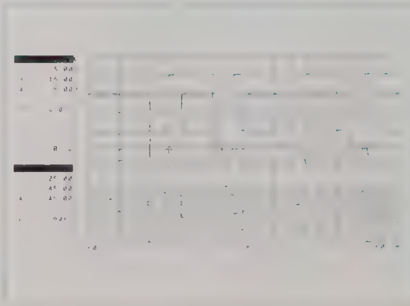
In the single mode, measured waveforms can be superimposed over previous traces as many times as required, which allows the drift in the characteristics of a machine, etc. to be observed more easily.



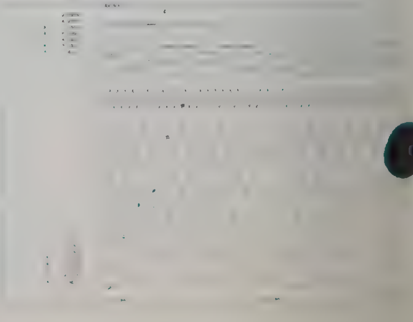
## Recording

Five recording formats are available; the printing of a hard copy of what appears on the screen, plotting, analog recording, digital recording and listing setup parameters. Whatever appears on the screen can be printed by the AR1600's thermal printer as a hard copy. A5 and A4 sizes can be selected; when A5 is selected, the entire contents of the screen are printed in just 8 seconds. When analog recording is selected, waveform data for the specified range can be recorded on continuous chart paper with an extended time axis.

**Plotting**

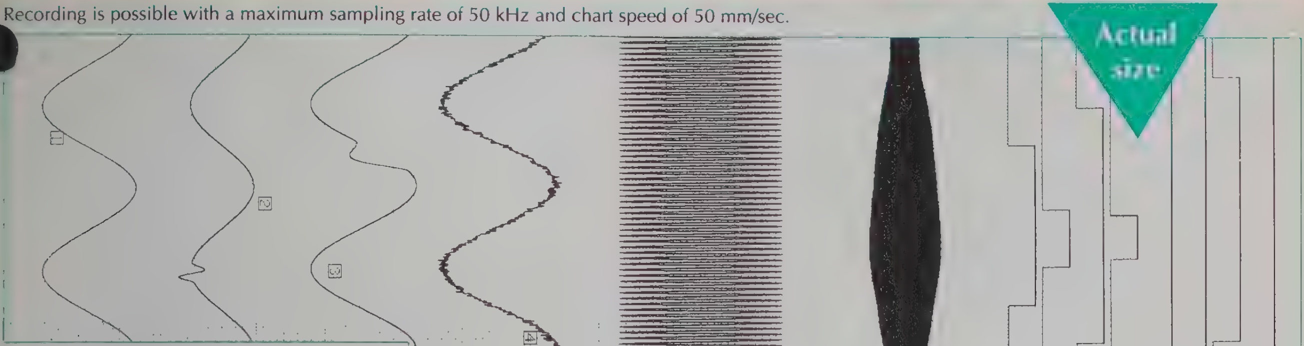


**Analog recording**

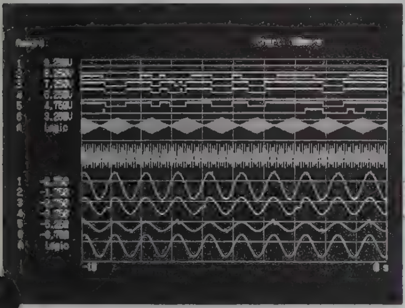


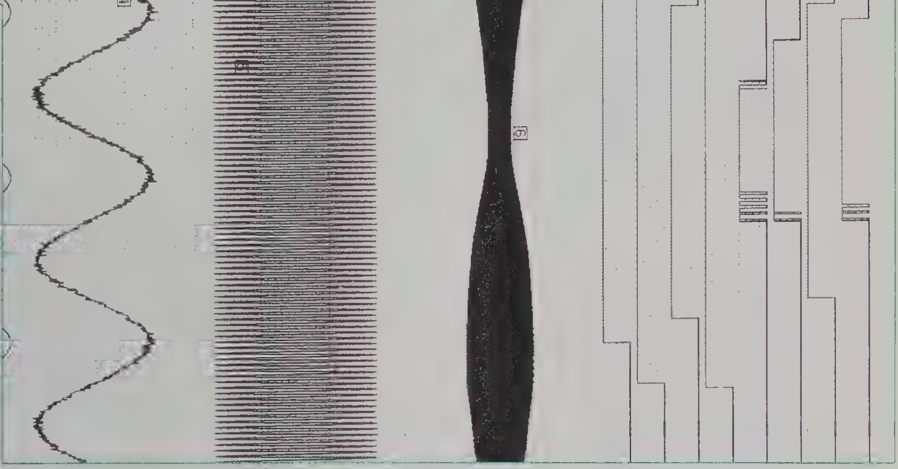
# Continuous recording over long periods … Recorder mode

Recording is possible with a maximum sampling rate of 50 kHz and chart speed of 50 mm/sec.



Using the roll mode, input waveforms for up to eight analog channels or 6 analog channels + 16 logic channels can be displayed in real time on the CRT. The user can observe the waveform on the screen and start printing out whenever required by pressing a button.





Power supply waveform (60 Hz)

Envelope recording (up to a frequency of about 5 kHz)

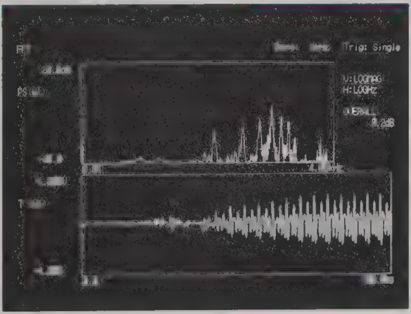
Logic level recording

# Frequency analysis … FFT mode (optional)

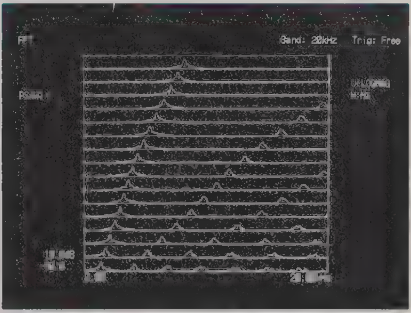
With its independent 14-bit A-D converters, the AR1600 can perform frequency analysis with the wide dynamic range of 72 dB. Any of 12 frequency ranges can be selected, with top frequencies from 4 Hz to 20 kHz. Frequency resolution is high, at 1/400.

Anaalytical functions provided in the AR1600 include linear spectrum (LS), power spectrum (PS), rms spectrum (RS), cross spectrum (CS), transfer function (TF), and coherence function (CH). To display the results of analysis, single trace, dual trace and Nyquist display formats can be selected. An array display format is also available.

**Power spectrum display**

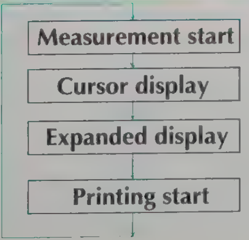


**Array display**



# Auto sequence function

When the operation procedure is programmed beforehand, the AR1600 automatically executes the individual processes in sequence. More than 20 types of operations are supported, including the start of measurement and printing, specifying the cursors, etc., so that fully automatic operation is possible.



# 3.5-inch FDD (optional)

Measured data can be stored on floppy disks in a variety of formats including ASCII and binary; a dump format is available for the transfer of large amounts of data. The setting conditions in each mode can also be saved.

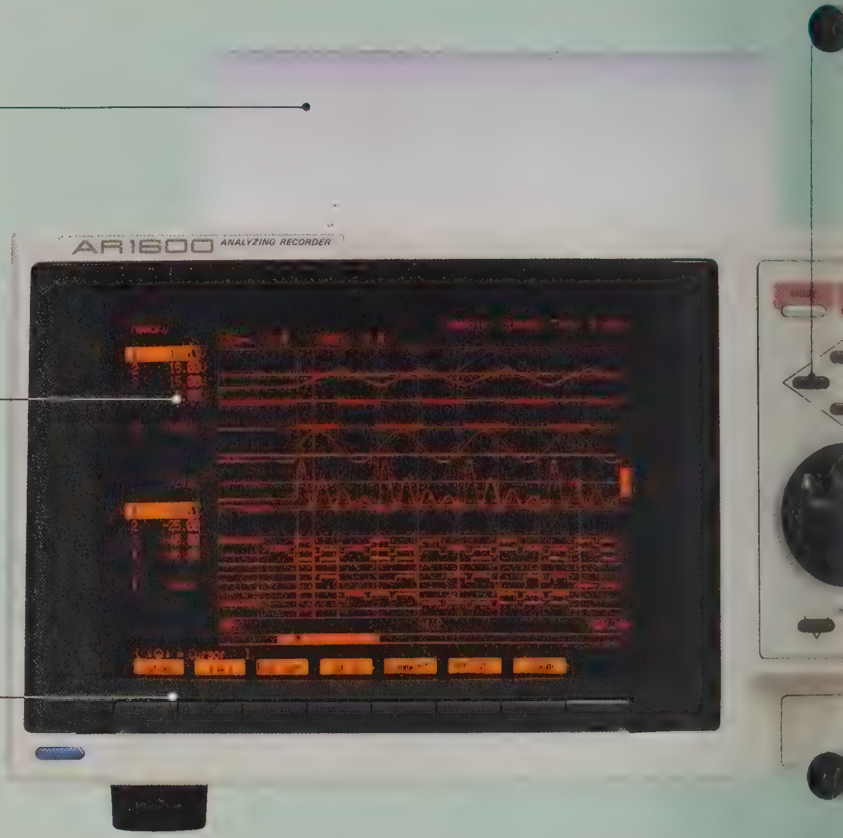
# All-in-one design — multiple functions with simple operation

## Front Panel

**210-mm chart paper**
**High-resolution thermal printer:**
The built-in thermal printer uses paper with a width of 210 mm (8-1/4"), for an A4 or A5 hard copy of whatever apperrs on the screen. In the continuous recording mode, printing is possible at the high speed of 50 mm/sec. 50-m (164-ft) continuous chart paper can be used.

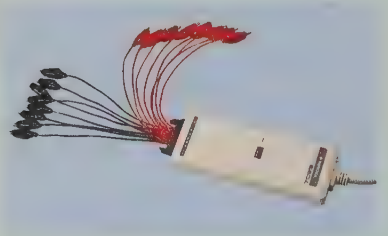
**Easy-to-view 9-inch CRT screen:**
program settings and waveforms can be seen clearly on the large amber display, for fatigue-free viewing over long periods.

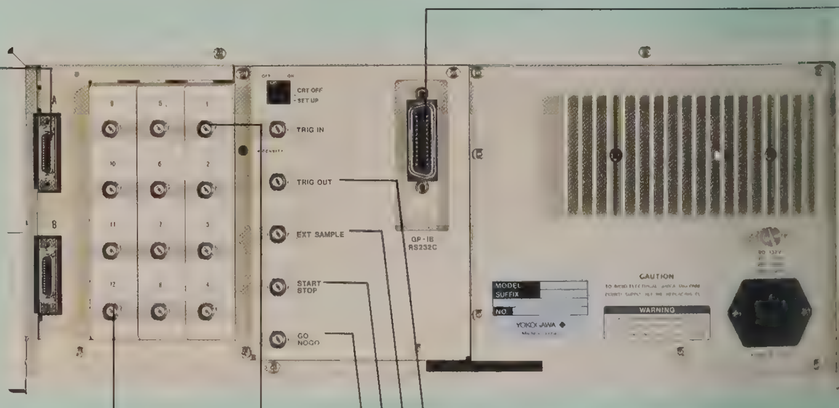
**Soft keys:**
These keys permit the setting of the mainparameters following the functions displayed across the bottom line of the CRT.



## Rear Panel

**Logic inputs:**
The AR1600 accepts two sets of 8-channel logic inputs. A switch on the probe allows the selection of either TTL level or contact signals.





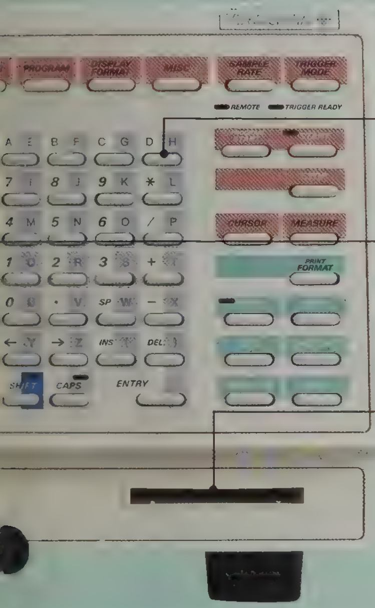
**Analog imputs:**
Models with 12 and 16 non-isolated input channels are avilable, with BNC connectors.

**TRIG OUT connector:**
Trigger pulse output connecter for parallel, synchronized operation with other equipment.

**TRIG IN connector:**
External trigger signal input connector. TTL level signal.

**ursor keys:**
he cursor keys are used to fine adjust the positions of cursors and to select items from parameters menus.

**Function selection keys:**
These are used to set and change the modes, input ranges, trigger conditions, programmed computation functions, display format, etc. and to call up the various setup screens.



**Numeric keypad:**
Used to enter programs and to key in titles.

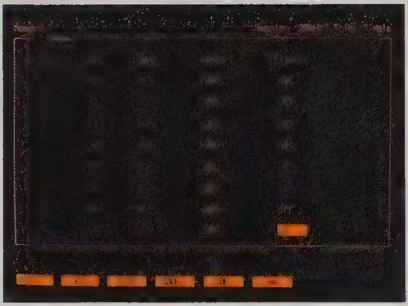
**Rotary dial:**
This is used to change the sampling speed, move the cursors, and to zoom and scroll in the memory mode.

**IC memory card slot:**
Waveform data, program data and setup parameters can be saved on an IC memory card, for quick loading whenever the same program is to be run in future.

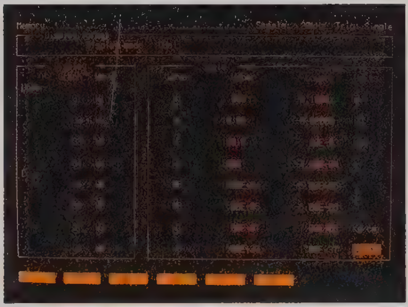
## User-friendly parameter menus for easier operation

Setting measurement conditions and other parameters is easy, using the cursor keys and soft keys, with interactive operations referring to on-screen displays. The parameter menus, with their hiearchical structure, allow operation by even untrained engineers.

**RANGE**
When setting input range for each channel.



**DISPLAY FORMAT**
When setting the data display format.



**GP-IB/RS-232-C interface:**
The communications functions allow full remote control from a personal computer or dedicated controller, while measured values and computed data can be transmitted to the personal computer. (Either a GP-IB or RS-232-C interface can be installed.)

**EXT SAMPLE connector:**
External sampling signal input connector. TTL level signal.

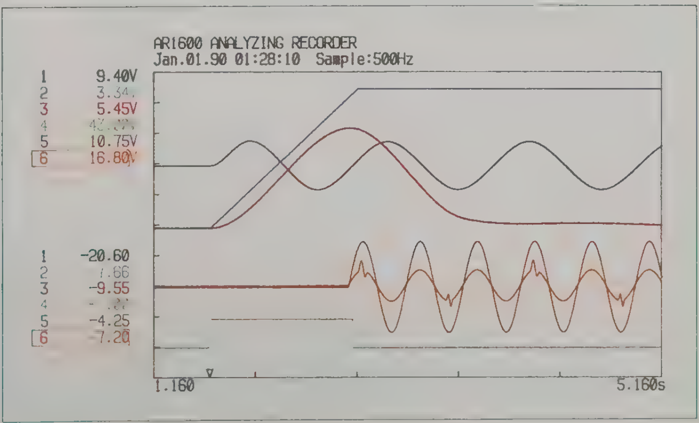
**START/STOP connector:**
Input connector for external control of starting/stopping measurement. TTL level or contact signal.

**O/NO-GO connector:**
Output connector for GO/NO-GO judgements in waveform measurement. TTL level signal.

## HP-GL plotter output

In addition to hard copies printed by the built-in thermal printer, when connected to an HP-GL compatible plotter via its GP-IB or RS-232-C interface, colored waveforms, etc. can be plotted. UP to 12 pen colors can be used, with A5, A4 and A3 paper.

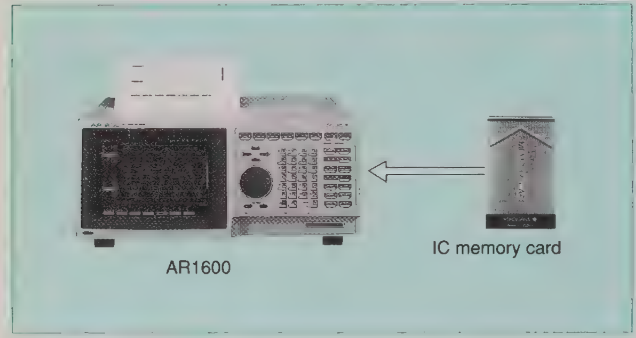
HP-GL compatible plotters:
Hewlett-Packard: 7475A
7550A



# Designed for a variety of applications when connected in different configurations

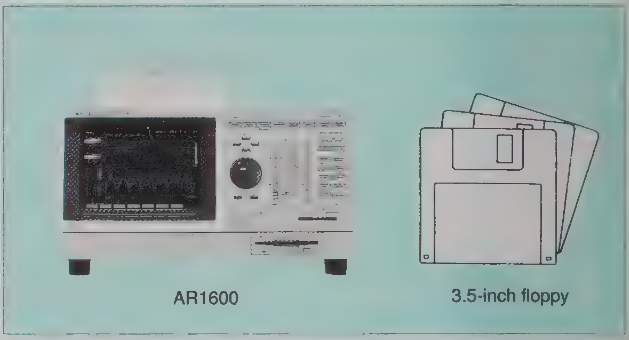
## Portability that makes it ideal for on-site use:

Weighing only 15 kg, the AR1600 is an all-in-one measuring instrument which makes possible on-site testing almost anywhere. When the same mesurement is to be performed repeatedly, settings and other data can be stored on an Ic memory card, to be recalled whenever required.



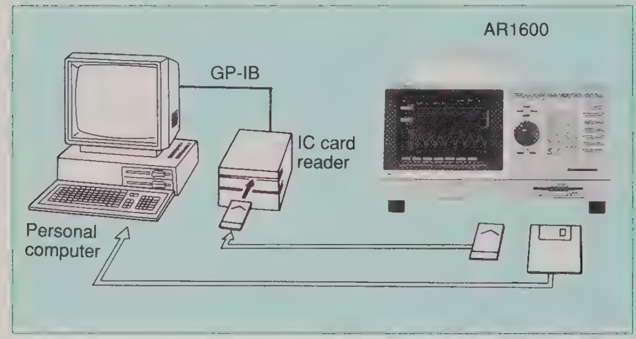
## Floppy disk data storage (optional):

Data can be saved on 3.5-inch floppy disks for product evaluation, periodical inspections, etc.,so that it can be recalled for further processing and comparison.



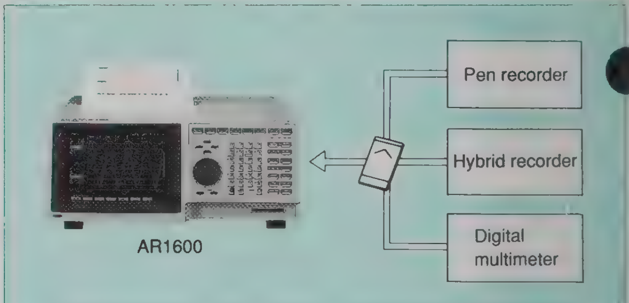
## Efficient data processing when used with a personal computer

By connecting a personal computer, data saved on an IC memorycard or 3.5-inch floppy disk can be manipulated.



## Analysis of data collected by other equipment

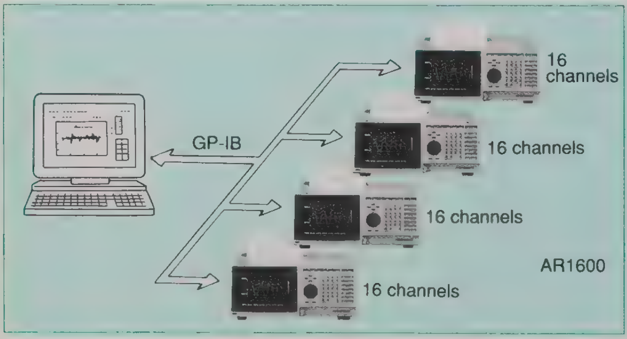
Data stored on IC memory cards by other YOKOGAWA instruments can be read and analyzed by the AR1600.



Compatible instruments: LR8100/4200/4100, HR1300/2300/2400, 7550/7560, etc

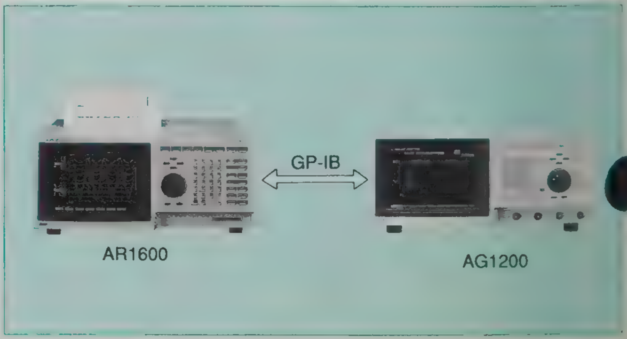
## Parallel operation for more sophisticated analysis

The AR1600 is designed so that up to 4 units can be used in parallel, synchronized operation. When 4 units are connected in palallel, with analog-only models, up to 64 channels can be measured; combined input models allow the measurement of up to 64 logic input channels and 48 analog channels. An even more efficient system can be constructed using an engineering workstation, etc.



## Simulated waveform output

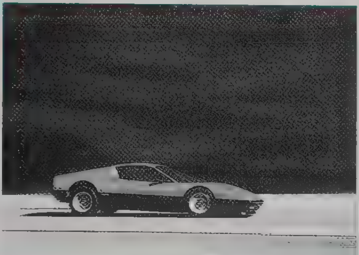
With the AG1200 waveform generator connected to the AR1600, measured waveform data can be transferred to the AG1200 which then generates the same waveform to be fed back to the AR1600, for simulation. This feature is effective in the design of sensor amplifiers, when performing control constant evaluations, etc.



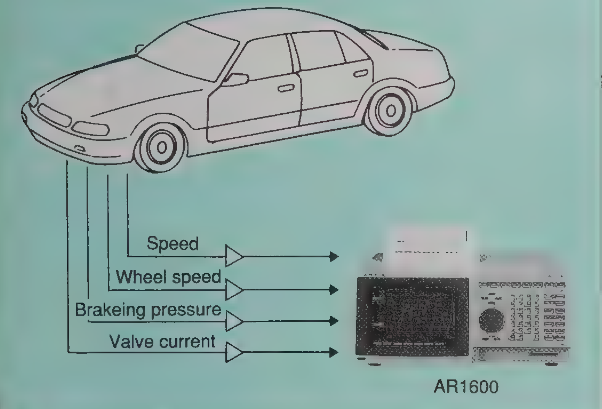
# Examples of the AR1600 used in a wide range of applications

## Automobiles and other vehicles:

- Engine characteristics tests
- Gear shift characteristics tests
- Steering characteristics tests
- Torque convertor characteristics tests
- Data analysis of moving vehicles
- Diagnosis of transmission problems in trains

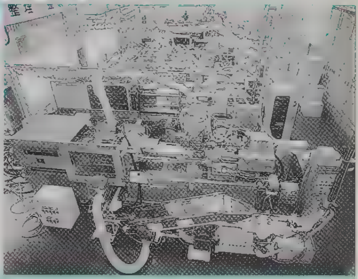


- Evaluation of Anti-skid Brake System

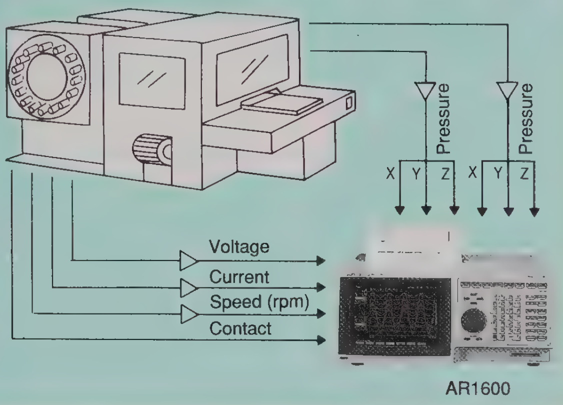


## Machinery, processing plants:

- Robot characteristics tests
- Printing machine performance tests
- Injection molding performance tests
- Analysis of sequencer operation
- Plant maintenance i.e. diagnosis of manufacturing facilities



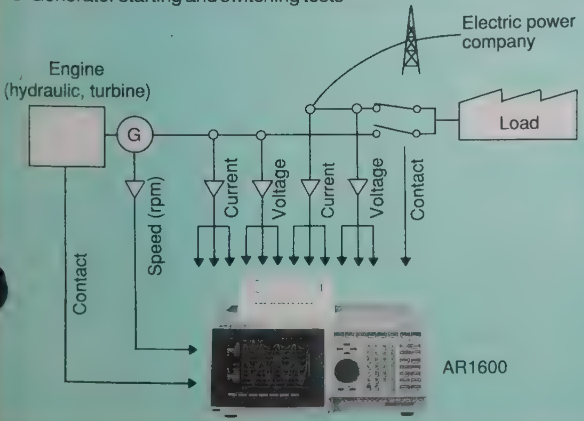
- Lathe evaluation



## Heavy electrical machinery and electric power generation:

- Motor efficiency tests
- Inverter power supply efficiency tests
- Uninterrupted power supply efficiency tests
- Generator characteristics tests
- Frequency converter characteristics tests
- Analysis of control panel problems

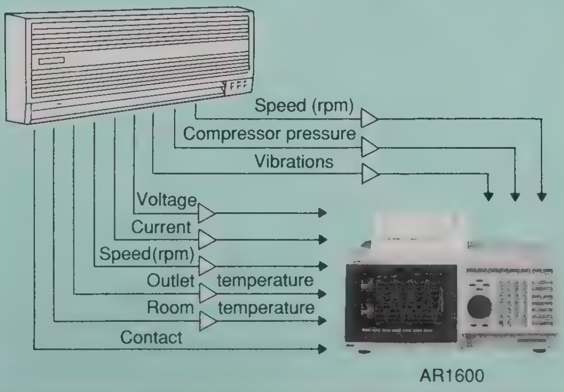
- Generator starting and switching tests



## Domestic electric applications, etc.

- Refrigerrator performance tests
- VTR performance tests
- Sewing machine performance tests
- Packaged goods dropping and impact tests
- Structural vibration-resistance tests

- Total evaluation of air-conditioner performance



# Specifications

## Analog input section

### Voltage input

| | |
|---|---|
| Number of input channels: | 12(7023 5□ , 7023 6□ ), 16 (7023 7□ ) |
| Input type: | Non-isolated input (unbalanced direct-coupled) |
| Maximum input voltage: | 90 V rms and 130 V peak |
| Measuring range: | ±60, 200, 600 mV, 2, 6, 20 V F. S. |
| Input impedance: | Approx. 1MΩ |
| Input bias current: | 2 nA (typical) |
| Frequency bandwidth (with filter OFF): | DC to 20 kHz ( $^{+1}_{-3}$dB typical DC coupled)<br>1 Hz to 20 kHz ( $^{+1}_{-3}$dB typical AC coupled) |
| Input coupling: | DC or AC |
| Accuracy: | ±(0.25% of F. S. + 50 µV)<br>(With filter OFF, DC, 23 ± 3°C) |
| Noise: | 120 µVp-p (typical)<br>at 60 mV range, input shorted |
| Temperature coefficients: | Zero point: Auto-calibration before measure ment After auto-cal., 0.02% of F.S./°C<br>Gain: Auto-calibration before measurement After auto-cal., 0.01%/°C |
| Allowable signal source impedance: | 500 Ω, max. |

### Filters

| | |
|---|---|
| Selectable filters: | Line filter (LIN), low pass filter (LPF, AUTO), OFF |
| Cut-off frequency (-3 dB, typical): | Line filter: 1.5 Hz<br>Low pass filter: 40, 400 Hz, 4 kHz, OFF |
| Cut-off characteristics (typical): | Line filter<br>Rejection ratio: –50 dB/50 or 60 Hz<br>Low pass filter: –24 dB/octave |

Modes and filters:

| Filter | Memory mode | Recorder mode | FFT mode |
|---|---|---|---|
| LINE | ○ | ○ | – |
| LPF | ○ | ○ | – |
| AUTO | ○ | (=OFF) | ○ |
| OFF | ○ | ○ | ○ |

(LINE: Line filter, LPF: Low pass filter)

### A-D converters (one for two channels)

| | |
|---|---|
| Resolution: | 14 bits |
| Conversion speed: | 10 µs (Each channel: 20 µs) |
| Measurement method: | Simulataneous measurement on all channels |

## Logic input section

| | |
|---|---|
| Number of input channels: | 16 (7023 6□) |
| Maximum input voltage: | ±35 V |
| Input impedance: | 10 kΩ or more |
| Threshold level: | Approx. 1.4V (TTL) |
| Input type: | TTL level or contact input (switchable) |
| Withstand voltage: | Between input clip and case; 500V DC for 1 minute |
| Insulation resistance: | Between input clip and case; 10 MΩor more at 500V DC |

## Memory mode

### Memory

| | |
|---|---|
| Maximum memory capacity: | 64k words/channel (7023□1)<br>256k words/channel (7023□3) |
| Memory elements: | DRAMs (Volatile memory) |
| Memory methods: | Selectable between standard, coupled and partitioned |
| Standard: | Writes upto 64K words (7023□1) or 250K words (7023□3) for each channel. |
| Coupled: | Even-channel memories are coupled to odd-channel memories for writing; only odd channels are usable, and programmable processing, averaging and specifying memory partitioning cannot be performed |
| Partitioned: | Each channel memory is divided into blocks and writing is done to each block at every trigger; verageing cannot be performed |
| Number of memory partitions: | 4, 8, 16, 32, 64, 128 blocks, selectable; maximum number of blocks determined by maximum memory capacity and programmable processing |

Maximum data capacity per channel: (k = 1,000 words/channel)

| | |
|---|---|
| Standard: | W/o averaging and programmable processing; 64k (7023□1), 256k (7023□3)<br>W/o averaging, with programmable processing; 16k (7023□1), 64k (7023□3)<br>With averaging, w/o programmable processing; 16k (7023□1), 64k (7023□3)<br>With averaging and programmable processing; 8k (7023□1), 32k (7023□3) |
| Coupled memory: | 125k (7023□1), 500k (7023□3) |

Memory partitioning:

| Maximum memory capacity | Programmable processing specified | Number of memory partitions | | | | | |
|---|---|---|---|---|---|---|---|
| | | 4 | 8 | 16 | 32 | 64 | 128 |
| | | Maximum data capacity per channel (kwords/ch) | | | | | |
| 64k (7023□1) | No | 16 | 8 | 4 | 2 | 1 | × |
| | Yes | 4 | 2 | 1 | × | × | × |
| 256k (7023□3) | No | 64 | 32 | 16 | 8 | 4 | 2 |
| | Yes | 16 | 8 | 4 | 2 | 1 | [illegible] |

| | |
|---|---|
| Data Write Interval: | 20, 50, 100, 200, 500 µs, 1, 2, 5, 10, 20, 50, 100, 200, 500 ms, 1, 2, 5, 10 s per word and external sampling clock (EXT SAMPLE, 50 kHz max.) |
| Time axis accuracy: | ±0.02% |

### Triggering

| | |
|---|---|
| Start/stop: | Three methods to start and stop measurement can be selected<br>(1) Start/Stop key operation on front panel(2) External START/ STOP signal (start caused by contact open →Close, stop caused by contact close→Open)(3) GP-IB or RS-232-C commands |
| Trigger modes: | FREE, SINGLE, REPEAT (selectable) |
| FREE: | Measurement starts with START and stops with STOP (measurement is done regardless of whether the trigger condition is satisfied) |
| REPEAT: | With START, the trigger stand-by mode is engaged. After that, each time the triggering condition is satisfied, writing is done to the entire memory; with STOP, the trigger stand-by mode is released. However, if the memory is partitioned, the block number is counted up for each trigger and after the last block has been written, the trigger stand-by mode is released. |
| SINGLE: | With START, the trigger stand-by mode is engaged. When the triggering condition is first satisfied, writing is done to the entire memory and the trigger stand-by mode is released immediately. If the memory is partitioned, the block number is counted up after writing and the stop mode is engaged. |
| Trigger sources: | Internal (INT), external (EXT), selectable |
| Internal trigger: | Combination trigger |
| Analog input | |
| Triggering system; | digital trigger using data measured on each channel |
| Trigger source; | four source channels can be specified |
| Selectable trigger combinations; | AND or OR, selectable: trigger with AND or OR of all sources: after specifying the same chan for two sources, bi-slope and window triggering possible |
| Trigger ON/OFF; | ON/OFF can be specified for each source: with OFF= don't care |
| Trigger level; | –100% to +100%, setting resolution of 1% |
| Trigger slope; | rising or falling edge, selectable |
| Trigger status; | high or low, selectable: with HIGH, trigger is effective about the trigger level: with LOW, trigger is effective below the trigger level |

| | |
|---|---|
| Logic input | |
| Triggering system: | digital triggering using data measured on each channel |
| Trigger source: | 8 points x 2 |
| Selectable trigger combinations: | AND or OR selectable; trigger with AND or OR of all source |
| Trigger ON/ OFF: | ON/OFF can be specifies for each source; with x = don't care |
| Trigger slope: | rising or falling edge, selectable |
| Trigger status: | high or low, selectable |
| External trigger: | Trigger with TRIG IN signal (TTL level) |
| External trigger slope specified: | selectable from rising or falling edge |
| Pretrigger (negative delay): | Can be set for external and internal triggers |
| Setting range: | 0 to 100%, can be set in 10% steps |

## Analytical processing

| | |
|---|---|
| Linear scaling: | After setting the offset value and scale factor value for setting value of each channel, scaling is done for each data acquisition and the obtained data is used as the measured data |
| Averaging: | Selectable among OFF, simple averaging and exponential averaging |
| Number of times (attenuation constant): | Select from 4, 8, 16, 32, 64, 128, 256 |
| Programmable processing: | Possible to define computation formula from a combination of functions |
| Number of formulae: | 8 |
| Number of characters in formula: | 55 characters, max. |
| Operators: | +, − ,x, ÷, (,) |
| Variables: | Measured data from each channel and data from IC memory card (4 channels) |
| Constants: | 20, max |
| Functions: | SQR (square root), LOG (logarithm), EXP (exponent), ABS (absolute value), DIF (differentiation), DDIF (double differentiation), INTG (integration), IINTG (double integration), MEAN (10 to 128 point moving average), SIN, COS, TAN, ASIN, ACOS, ATAN ( averaging, differentiation and integration can be executed only once in a formula) |
| Zone statistical computation: | The zone of the waveform on the screen specified with the two cursors is processed and displayed |
| Types of zone statistical computations: | Area (area between waveform and cursors, or enclosed by a waveform, for T-Y and X-Y waveforms), maximum value, minimum value, P-P value, average, RMS value, standard deviation (between cursors) |
| Waveform judgment: | Judgment is done for one specified channel |
| Judgment area definition: | Done by moving displayed waveform up, down, to left and right. Averaged and processed waveform can be used. |
| Judgment actions: | Auto save or automatic recording (selectable) |
| Auto save: | Only Go waveforms or No-go waveforms are stored in sequential memory |
| Automatic recording: | Only Go waveforms or No-go waveforms are recorded |
| GO/ NO GO output: | Outputs Go/No-go signals (TTL level) |

## CRT display

| | |
|---|---|
| Display format: | SINGLE display—1 to 8 channels or 16 logical channels (6 analog channels) displayed on one screen<br>DUAL Display—1 to 4 channels displayed on each of two subscreens<br>QUAD display—1 channel displayed on each of four subscreens<br>X-Y display—4 channels displayed |
| Cursor: | Digital display of data at the selected point |
| Reference cursor: | Differences between cursor and reference cursor displayed |
| Scroll: | |
| Vertical direction: | Scrolls only waveform specified by cursor |
| Horizontal direction: | Scrolls all waveforms on the same screen |
| Zoom: | |
| Vertical direction: | Magnifies waveform specified by cursor; with X-Y display, both X and Y axes are magnified on vertical axis |
| Horizontal direction: | Magnifies all waveforms being displayed |
| Grid display: | ON/OFF possible |
| Display scale: | Scales display on vertical axis (upper limit, lower limit) |
| Superimposed display: | Newly-measured waveform is superimposed over waveform stored in memory |
| Accumulate display: | Waveform are superimposed without clearing previous ones |
| Others; | Display of specified block, program start |

## Printing

| | |
|---|---|
| Size: | A5 (screen hard-copy), A4, or required data length (analog, digital recording) |
| Mode: | (1) Screen hard-copy<br>Recording resolution: 640 x 400 (same as CRT display)<br>(2) Plotting of CRT screen<br>Recording density: 8 dots/mm<br>(3) Analog recording of data in specified range<br>Recording density: 8 dots/mm<br>Time-axis waveform recording resolution: 20 dots/mm<br>(4) Digital list printing: prints setup information<br>(5) Setup list printing: prints setup information |
| Title: | Title can be printed at top of hard copy, etc. (up to 40 characters)<br>Available characters: alphanumerics, parentheses, +, –, x, and+ |
| Automatic printing start function: | Recording at trigger or at Go/No-go judgment point |

## Recorder mode

### Recording

| | |
|---|---|
| Recording format selection: | Analog trend or digital trend, selectable |
| Analog trend: | Waveform recorded on the continuous chart |
| Recordable data: | Measured data of each channel |
| Number of recording channel: | 8 max. (analog) or 6 (analog) + 16 (logical) |
| Scaling: | Linear scaling possible for each channel (analog) |
| Sampling interval: | 20 µs (50 kS/s) |
| Recording method: | Recording possible filling the zone between the maximum<br>and minimum values of measurement samples at the maximum recording density of the thermal printer |
| Effective chart width: | 200 mm |
| Chart length: | 50 m |
| Chart speed: | 10, 20, 50 mm/h, 1, 2, 5, 10, 20, 50 mm/min, 1, 2, 5, 10, 20, 50 mm/s |
| Recording color: | Black |
| Recording density: | 8 dots/mm |
| Time-axis waveform recording resolution: | 32 dots/mm |
| Recording accuracy: | Measurement accuracy, ±0.125 m (1 dot) |
| Digital trend: | listing of digital value of waveform data, the interval to be selected from 1, 2, 5, 10, 20, 30 and 60 s |

### Trigger

| | |
|---|---|
| Time trigger: | Specifies the recording start and stop date and time (month/day/hour/minute) |
| Fixed time recording: | Starts and stops recording at the specified time (hour/minute) every day |

### CRT display

| | |
|---|---|
| Display format: | Roll mode |
| Number of displayed waveforms: | Max. 8 (analog), or 6 (analog) + 16 (logic) |
| Display time range setting: | 0.5, 1, 2.5, 5, 10, 25, 50, 100, 250 s, selectable |
| Display update cycle: | 1/500 of the display time range |

## FFT mode (option)

### Trigger

Same as memory mode

### Analysis and display

| | |
|---|---|
| Number of channels: | 2 channels |
| Channel select: | Waveform data of the specified input channel or that written to IC card in the memory mode |
| Engineering units: | Converts input voltage from external transducer to technical units |
| Analysis functions: | Linear spectrum, power spectrum, power spectrum density, over-all, RMS spectrum, cross spectrum, transfer function, coherence function |
| Frequency :. | |
| Frequency range : | 4, 8, 20, 40, 80, 200, 400, 800 Hz, 2, 4, 8, 20 kHz |
| Frequency resolution: | 1/400 of the frequency range |
| Window: | Hanning or rectangular |
| Dynamic range: | 72 dB (typical) |
| Sampling: | |
| Sampling frequency: | 2.5 times analysis frequency range |
| Frequency accuracy: | ±0.02% |
| Number of sampling points: | 1,000 points |
| Averaging: | |
| Time-axis averaging: | OFF, simple average, exponential average |
| Frequency-axis averaging: | OFF, simple average, peak hold; with peak hold, frequency analysis is performed several times and the maximum value is displayed |
| Number of times (attenuation constant): | Select from 4, 8, 16, 32, 64, 128, 256 |
| Display format: | Single display; 1 analysis result display<br>Dual display; 2 analysis result display Time-axis waveform simultaneous display possible<br>Nyquist display<br>Array display; Analysis result of 16 time series is displayed |
| Cursor: | Reading of the frequency and analyzed value |
| Reference cursor: | Reading of the difference in the frequency and analysis value between two points |

Notes) Anti—aliasing filter is not included

### Recording

| | |
|---|---|
| Size: | A5 (for screen hard-copy), A4 |
| Mode: | (1) Screen hard-copy<br>Recording resolution; 640 x 400 (same as CRT display)<br>(2) Plotting of screen<br>Recording density; 8 dots/mm<br>(3) Setup list printing |
| Title: | Same as in memory mode |

## General specifications

CRT display: 9-inch CRT (display color: amber), 640 x 400 dots, 4 levels

### Recording

| | |
|---|---|
| Recording system: | Thermal printer |
| Effective width: | 200 mm |
| Recording density: | 8 dots/mm |
| Time-axis waveform resolution: | 20 dots/mm (memory mode, analog recording), 32 dots/mm (recorder mode, analog trend) |
| Recording speed: | 50 mm/s max. (recorder mode), 20 mm/s (hard copy, etc.) |

### External input/output signals

| | |
|---|---|
| TRIG IN: | TTL level _↑‾ or ‾↓_ (pulse width of 2 μs or more) |
| TRIG OUT: | TTL level _↑‾_ (pulse width of 3 μs or more) for parallel operatior |
| EXT SAMPLE: | TTL level _↑‾_ 50 kHz max. (pulse width of 2 μs or more) |
| START/STOP: | Contact signal: Start when Open →Close<br>Stop when Close→Open |
| GO/NO-G0: | TTL level ‾↓_‾ (100 ms≤Pulse width≤150ms) |

### Others

| | |
|---|---|
| Clock accuracy: | ± 50 ppm (typical) |
| Battery back: | Setting value memory and clock backed up by lithium battery with life of approx. 10 years (at ambient temperature of 23°C) |
| Operating environment: | 0 to 40°C, 30 to 80% Rh (non-condensing); 5 to 35°C for printer, FDD operation |
| Withstand voltage: | Between power supply and case; 1,500 V AC for 1 minute |
| Insulation resistance: | Between power supply and case; 10 MΩor more at 500V DC |
| Power Supply: | Rated Power Supply Voltage: 100-120 VAC/200-240 VAC (automatic switching)<br>Power Supply Voltage Tolerance: 90-132 VAC/180-250 VAC<br>Rated Power Supply Frequency: 50/60 Hz<br>Power Supply Frequency Tolerance: 48-63 Hz |
| Power consumption: | |
| When printer is not operating: | With 100-120 V AC, approx. 135 VA (70235☐), approx. 150 VA (70236☐, 70237☐)<br>With 200-240 V AC, approx. 225 VA (70235☐), approx. 250 VA (70236☐, 70237☐) |
| When printer is operating: | With 100-120 V AC, 500 VA max., with 200-240 V AC, 700 VA max. |
| Accessories: | Thermal chart paper (1 roll, 210 mm x 50m), power cord, fuse (3.15A), chart holder, instruction manua logic probes (7023 6☐) x 2 |

## Interface (either GP-IB or RS-232-C can be selected)

### GP-IB interface

| | |
|---|---|
| Standard: | Conforms to IEEE Standard 488-1978 |
| Functional specifications: | SH1, AH1, T5, L4, SR1, RL1, PPO, DC1, DTO, CO |
| GP-IB functions: | Setting value input/output, measured value output (setting and control excluding power ON/OFF), HP-GL plotter output |

### RS-232-C interface

| | |
|---|---|
| Standard: | Conforms to EIA RS-232-C |
| Transmission rate: | 75, 150, 300, 600, 1200, 2400, 4800, 9600 bps |
| RS-232-C functions: | Setting value input/output, measured data output (Setting and control excluding power ON/OFF), HP-GL plotter output |

### HP-GL plotter output (common to the GP-IB and RS-232-C interfaces)

| | |
|---|---|
| Applicable models: | HP; 7475A, 7550A |
| Plot output: | Plotting in the memory mode and FFT mode |

## Optional specifications and accessories

### 3.5-inch FDD (optional specifications/FDD)

| | |
|---|---|
| umber of drives: | 1 |
| Usable media: | 2HD, 2DD |
| Capacity: | 1.2 MBytes, 1.44 MBytes, 720 Kbytes |
| Memory data: | Specified part of waveform memory |
| Data readout display: | Waveforms can be displayed on screen when data is read from a 3.5-inch floppy disk into waveform memory |

### DC drive (optional specifications/DC12)

| | |
|---|---|
| Voltage: | 10 to 20 V |
| Others: | |
| Input type: | BNC input on front panel |
| With 3.5-inch FDD | |

### IC memory card (Optional accessory)

| | |
|---|---|
| Card slot: | 1 slot provided as standard |
| Memory capacity: | 512 Kbytes, 256 Kbytes, 64 Kbytes<br>2 bytes/word (measurement data) |
| Memory data: | Specified part of waveform memory |
| Panel setting information: | File size required for 1 setting is approx. 1.5 Kbytes |
| Data readout display: | Waveforms can be displayed on screen when data is read from IC memory card into waveform memory |
| Battery: | Lithium battery (life: approx. 3 years for 64 Kbytes, approx. 2 years for 256 Kbytes, approx. 1 year for 512 K,1Mbytes) |

### Power unit (Optional accessory)

| | |
|---|---|
| ut system: | PT isolated system (voltage), CT isolated system (current) |
| umber of input channels: | 2 (voltage), 2 (current) |
| Rated input: | 100, 150, 300, 600 V (voltage), 1, 2, 5, 10 A (current) |
| Output voltage: | 1.0 V at the rated input |
| Accuracy: | 0.2% of range |
| Operating frequency range: | 50 to 60 Hz, 2 kHz max. for harmonic content (amplitude flatness is within ±0.5% up to 2 kHz) |
| Withstand voltage between channels: | 1,000 Vrms |
| Dimensions: | Approx. 149 (H) x 228 (W) x 365 (D) mm (5–7/8" x 9" x 14–3/8") |
| Weight: | Approx. 10 kg (22.1 lbs.) |

## Model names and Suffix code

| Model | Suffix Code | | | Description |
|---|---|---|---|---|
| 7023 51 | ................................ | | | 12 channels, 64k words/ch memory |
| 7023 53 | ................................ | | | 12 channels, 256k words/ch memory |
| 7023 61 | ................................ | | | 12 channels + 16-channel logic, 64k words/ch memory |
| 7023 63 | ................................ | | | 12 channels + 16-channel logic, 256k words/ch memory |
| 7023 71 | ................................ | | | 16 channels, 64k words/ch memory |
| 7023 73 | ................................ | | | 16 channels, 256k words/ch memory |
| PowerRequirements | –0 | | | 100to120/200to240V AC (automatic switching) |
| Power Cord | | /D | | UL standard |
| | | /F | | VDE standard |
| | | /H | | SAA standard |
| | | /J | | BS standard |
| | | /M | | JIS standard |
| Optional Feature | | | /FFT | FFT function |
| | | | /GP-IB | GP-IB interface |
| | | | /RS232C | RS-232-C interface |
| | | | /FDD | 3.5-inch FDD |
| | | | /DC12 | DC 12 V drive (including/FDD and the front-panel input) |

Note: Specify either GP-IB or RS-232-C interface.

## Optional Accessories

| Name | Code | Description | Order Q'ty |
|---|---|---|---|
| Power unit | 3659 61 | 2 channels each for V and A | 1 |
| Conversion adapter | 3669 21 | BNC-banana | 1 |
| Conversion adapter | 3669 22 | Banana-BNC | 1 |
| Plug adapter | 3669 23 | T-shape | 1 |
| BNC cable | 3669 24 | BNC-BNC (1 m) | 1 |
| BNC cable | 3669 25 | BNC-BNC (2 m) | 1 |
| Clip lead | 3669 26 | BNC-clip (1 m) | 1 |
| IC memory card | 3789 03 | 64K bytes | 1 |
| IC memory card | 3789 04 | 256K bytes | 1 |
| IC memory card | 3789 05 | 512K bytes | 1 |
| IC memory card | 3789 06 | 1M bytes | 1 |
| Cleaning kit | 7009 21 | For CRT | 1 |
| 3.5-inch floppy disk | 7059 00 | 2HD | 10 |

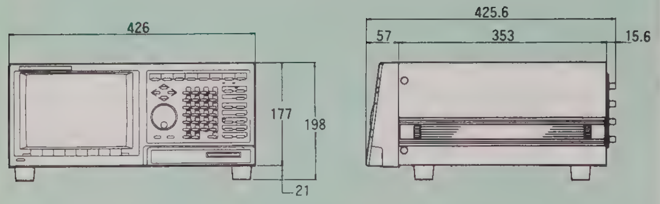
## Spares

| Name | Parts number | Description | Order Q'ty |
|---|---|---|---|
| Roll chart | B9879AJ | 50m length (1 roll/unit) | 6 |
| Lithium battery | B9586JU | For 3789 03 (1 pc./unit) | 2 |
| Lithium battery | 39586JV | For 3780 04/05/06 (1 pc./unit) | 2 |
| Logic probe | 7029 11 | 8-channel input (including B9879PX and B9879KX) | 1 |
| Connection lead | B9879PX | Crocodile clip | 1 |
| Connection lead | B9879KX | IC clip | 1 |
| DC power cable | 3659 97 | DC power connection cord | 1 |

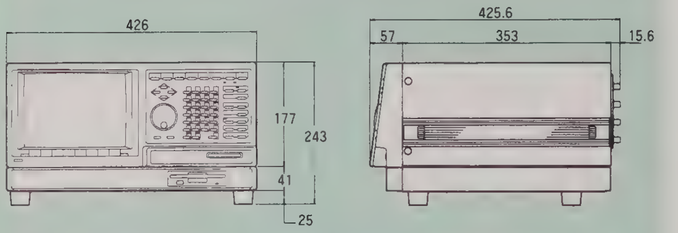
Notes: Order 6 rolls of chart paper at a time.
The logic probe is for 7023 6☐ .

## Dimensions

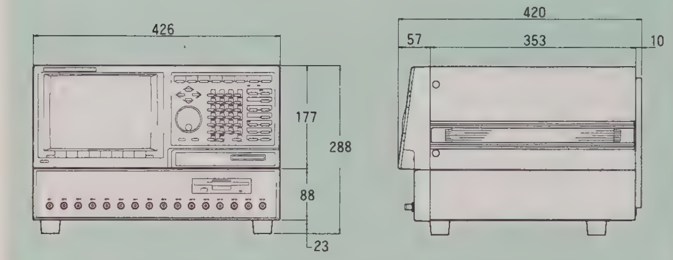
Unit: mm



Standard model Weight: Approx. 15 kg (30.9 lbs.)



Model with FDD Weight: Approx. 17 kg (35.5 lbs.)



Model with DC drive Weight: Approx. 20kg (44.1 lbs.)

## Optional Accessories and Spares

YOKOGAWA

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Subject to change without notice.

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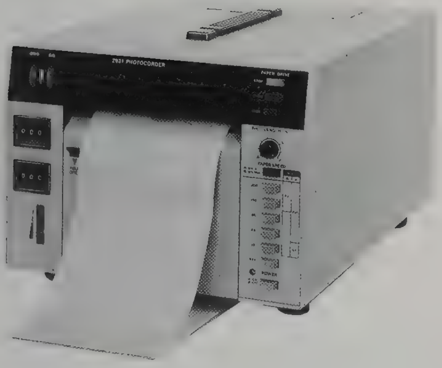
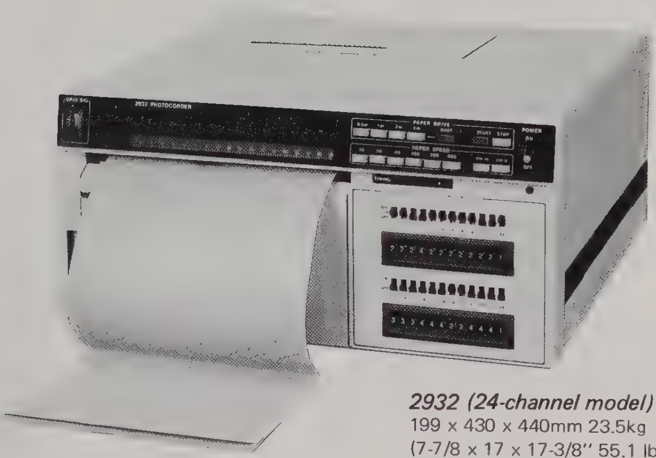
# 2931 & 2932 Photocorders



*2931*
199 x 280 x 409mm 15.0kg
(7-7/8 x 11 x 16-1/8" 33.1 lbs)



*2932 (24-channel model)*
199 x 430 x 440mm 23.5kg
(7-7/8 x 17 x 17-3/8" 55.1 lbs)

A full line of YEW Photocorders are compact, direct recording electromagnetic oscillographs, which produce high-quality photographic traces without special processing.

These Photocorders combine portability, reliability and simple operation. For optimum reliability and durability, high-quality components and advanced technology are used throughout including a DC servo paper drive, and mercury vapour lamp.

## MAIN FEATURES

- **Exceptionally compact**
- **Consistently stable paper drive and quiet operation by means of a DC servo mechanism**
- **178mm (2932) or 127mm (2931) effective recording width**
  Customer's 152mm or 203mm wide Z-fold papers are also compatible with 2932.
- **12 paper speeds from 10cm/min to 400cm/s**
  Paper speed of Model 2931 is selectable from 10cm/min to 200cm/s in 10 steps.
- **No vertical adjustment of galvanometer light spot**
  Conventional oscillographs require both vertical and horizontal adjustments of the galvanometer light spot. YEW Photocorders require only horizontal adjustment, which is performed simple by rotating the galvanometer.
- **Easy light spot observation and adjustment from wide view window**
- **Trace identification and numbering (standard for 18- and 24-channel models)**
- **Built-in 10-step input signal multipliers for each channel**
- **Automatic lighting and restarting of mercury vapour lamp even after momentary power failure**
- **PAPER SHOT pushbutton to select preset record length of 0.5 to 4m (stepless)**
- **Low power consumption**
- **A wide range of remote controls**
- **Wide selection of interchangeable galvanometers**

### DC amplifiers self-contained model (8 channels)

- **Expanded-scale recording of low-level signal**
  8-channel model amplifies 20mV p-p input signal up to about 50mm full span.
- **Built-in galvanometer protection circuit**
- **Selectable filtering (BAND LIMIT)**
- **Simple operation using two-in-one control dial**
  Gain range (outer dial), and BAND LIMIT (inner dial).

Available Models

| Number of Channels | Model | |
|---|---|---|
| | 50Hz | 60Hz |
| 6 | **293100** | **293100** |
| 9 | **293211** | **293212** |
| 18 | **293221** | **293222** |
| 24 | **293231** | **293232** |
| 8 (DC amplifiers self-contained type) | **293241** | **293242** |

## SPECIFICATIONS OF 2931

**Number of Channels:** 6.

**Galvanometers (Optional):** YEW Model 2916 (see back cover), 6 types available.

**Optical Arm:** Approx. 330 mm(13").

**Recording Chart:** 127 mm(5") wide Z-fold or roll chart.

**Light Source:** Mercury vapour lamp.

**Lamp Lighting System:** Lamp lights automatically after the power switch is turned on, and automatically restarts immediately after momentary power failures.

**Paper Speeds and Timing Intervals:**

| Paper Speeds | cm/min | | | | | cm/s | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 10 | 20 | 50 | 100 | 200 | 10 | 20 | 50 | 100 | 200 |
| Timing Intervals | 1 second | | | 0.1 second | | | 0.01 second | | | |

Timing intervals are selected automatically by setting paper speed.

**Paper Drive:** PAPER DRIVE START, STOP or SHOT are selected by pushbutton controls.

**SHOT:** Used to preset record length (SHOT LENGTH) of approx. 0.5 to 4 m(stepless) . . available on cm/s paper speed ranges.

**Residual Paper Stock Indicator:** The amount of chart remaining is indicated on a four-level mark scale from full (F) to empty(E).

**Input Signal Multipliers:** 455 kΩ max. in 10 steps by setting digital thumbwheel switch for each channel (fuse resistance 9 Ω).

**Input Signal Selectors:** Input signal to each channel can be selected by setting Input Signal ON/OFF Selector on the side panel.

**Light Intensity Adjustors:** Light intensities of recording traces or grid lines continuously variable by adjusting the SIG or GRID dial on the front panel.

**Adjustment of Galvanometer Light Spot:** Vertical adjustment of galvanometer light spot is unnecessary.

**Grid Lines:** Automatically marked at 2 mm intervals with every 5th line accentuated.

**Timing Lines:** Automatically marked at timing intervals selected by paper speed setting (TIME INT/EXT selector on the rear set at INT). Can be disconnected when TIMING selector set at EXT.

**Temperature of Magnet Block:** Galvanometer magnet block temperature is maintained at approx. 50°C.

**Operating Temperature Range:** 5 to 40°C (41 to 104°F).

**Humidity Range:** 45 to 80% relative humidity.

**Dielectric Strength:** 1,500 V AC for one minute between case and power line, 250 V AC for one minute between channels, and between all inputs and case.

**Insulation Resistance:** More than 10 MΩ at 500 V DC between case and power line, and between all inputs and case.

**Power Requirements:** 100, 110, 115, 120, 200, 220, 230 or 240 V AC +5%, –10% (must be specified), 50 and 60 Hz.

**Power Consumption:** Approx. 250 VA max.

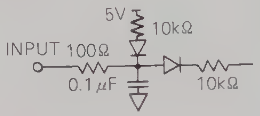
**Accessories supplied at no extra cost:** Galvanometer driver . . . 1 pc, 290905 Z-fold chart. . .1 chart, remote control connector plug (AMPHENOL 57-30140) . . . 1 pc, chart holder . . . 1 pc, chart roller . . . 1 pc, fuses (100 to 120 V AC; 3.15 A, 200 to 240 V AC; 1.6 A) . . . 3 pcs, power cord (2- or 3-prong type) . . . 1 set.

**Remote Controls (Standard):**

1) Remote control of paper drive START/STOP by external contact or TTL-level signal:
   L logic level or closed contact . . . PAPER DRIVE START.
   H logic level or open contact . . . PAPER DRIVE STOP.
2) Remote control of paper speeds by external signal:

| PAPER SPEED pushbutton: * EXT * cm/min or cm/s | 200 | 100 | 50 | 20 | 10 |
|---|---|---|---|---|---|
| External DC signal | 6V | 3V | 1.5V | 0.6V | 0.3V |

   Paper speeds are stepless.
3) Remote control of timing line intervals by external signal:
   Remote control signal waveforms: Sine, triangular or rectangular waveform.
   Signal level: ±4 to ±24 V, 1 to 100 Hz.
   Input circuit of 2931:



4) Contact signal output for remote operation:
   Simultaneous remote operations of up to 10 units possible using contact signal output.
   PAPER DRIVE START . . . closed contact.
   PAPER DRIVE STOP . . . open contact.
5) Timing synchronization:
   Timing can be synchronized by external TTL-level signal.

## SPECIFICATIONS OF 2932

**Galvanometers (Optional):** YEW Type 2916 (see back cover), 29321□, 29322□, 29323□ . . . selectable from 6 types, 29324□ . . . **291603.**

**Optical Arm:** Approx. 330mm, or 13" (length of optical path from the galvanometer mirror to the surface of the chart).

**Recording Paper:** Z-fold chart of 178mm (7") wide x 30, 45.7 or 60m long. 152mm (6") or 203mm (8") wide Z-fold charts are also usable (to be furnished by user).

**Light Source:** Mercury vapour lamp.

**Lamp Lighting System:** Lamp lights automatically after the power switch is turned on, and automatically restarts immediately after momentary power failures.

**Chart Speeds and Timing Intervals:**

| Chart Speeds | cm/minute | | | | | | cm/second | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 10 | 20 | 40 | 100 | 200 | 400 | 10 | 20 | 40 | 100 | 200 | 400 |
| Timing Intervals | 1 second | | | 0.1 second | | | | 0.01 second | | | | |

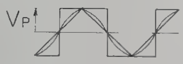
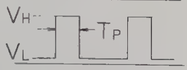
Timing intervals are automatically selected by the chart speed setting, and shown on TIMING indicator on the front panel. Timing can be synchronized by an external signal.

**Chart Drive:** PAPER DRIVE START, STOP or SHOT are selected by pushbutton controls. SHOT is used to preset record length of 0.5, 1, 2 or 4 meters.

**Residual Chart Stock Indicator:** The amount of chart paper remaining is indicated on a scale of four level marks from full to empty.

**Remote Controls:**

1) Remote control of chart drive START/STOP by external contact, open collector or TTL-level signal:
   L logic level or closed contact . . . . CHART DRIVE START.
   H logic level or open contact . . . . CHART DRIVE STOP.
2) Remote control of timing line intervals by external signal:

| **Remote control signal waveforms** | Sine, triangular and rectangular waveforms | Pulse train |
|---|---|---|
| **Signal level** |  <br>$4V < V_P < 24V$ |  <br>$+4V < V_H < +24V$<br>$-24V < V_L < +0.5V$<br>$T_P > 100 \mu S$ |
| **Maximum signal source impedance** | 600Ω | 50Ω |
| **Maximum frequency** | 100Hz | 100 pulses per second |

**Remote Operations:** Simultaneous remote operations (chart drive START/STOP, SHOT and timing lines) of up to 10 units possible.

**Input Signal Multipliers:** 0 to approx. 455kΩ in 10 steps by setting of digital thumbwheel switch for each channel (except for DC amplifiers self-contained type).

**Input Signal Selectors:** Input signal to each channel can be selected by setting of Input Signal ON/OFF Selector on the front panel (except for DC amplifiers self-contained type).

**Light Spot Selectors:** Spot ON/OFF selectors for each channel provided on the top panel. Shuts off unused light spot at OFF position.

**Light Intensity Adjustors:** Light intensities of recording traces or grid lines continuously variable by adjusting the SIG or GRID dial on the front.

**Adjustment of Galvanometer Light Spot:** Vertical adjustment of galvanometer light spot is unnecessary.

**Grid Lines:** Automatically marked at 2mm intervals with every fifth line accentuated. Can be disconnected by GRID dial control when not required.

**Timing Lines:** Automatically marked at timing intervals selected by chart speed setting (TIMING INT/EXT selector on the rear set at INT). Can be disconnected when TIMING selector set at EXT. Remote control of timing line intervals is possible by external signal.

**Trace Identification and Numbering:** Provided with 18- and 24-channel models. Each trace in order is interrupted, and its number marked along the left (upper) edge of chart. Trace identification and numbering can be disconnected, when not required, by means of an ON/OFF selector switch on the top panel.

**Temperature of Magnet Block:** Galvanometer magnet block temperature is maintained at approx. 50°C.

**Operating Temperature Range:** 5 to 40°C (41 to 104°F).

**Humidity Range:** 45 to 80% relative humidity.

**Dielectric Strength:** 1,500V AC for one minute between case and power line, 250V AC for one minute between channels, and between all inputs and case.

**Insulation Resistance:** More than 100MΩ at 1,000V DC (500V DC on 29324□) between case and power line, 500V DC between channels, and between all inputs and case.

**Power Requirements:** 100, 120, 200, 220 or 240V AC± 10%, 50 or 60Hz (must be specified).

**Power Consumption:** Approx. 300VA.

**Weight (Approx.):** 9-channel model . . . 20.5kg (42.5 lbs), 18-channel model . . . 22.5 (49.6 lbs), 24-channel model . . . 23.5kg (51.8 lbs), 8-channel model . . . 25kg (55.1 lbs).

**Panel and Case Colors:** Front panel and case . . . green-yellow (Munsell 2.5GY 7/1), rear panel and handles . . . green-yellow (Munsell 2.5GY 3/1).

**Accessories supplied at no extra cost:**
Input signal cords (8, 9, 18 or 24 sets), Z-fold chart (1 chart), remote control connector plug (1 pc), galvanometer driver (1 pc), fuses (6 pcs), accessory box (1 pc), power cord (2- or 3-prong type, 1 set).

**Optional Accessory:** **293510** rack adapter.

## SELF-CONTAINED DC AMPLIFIERS (293241, 293242)

**Number of Channels:** 8 (2 channels/unit).

**Type:** Direct-coupled DC amplifiers (floating between channels).

**Input Circuit:** Unbalanced, floating and guarded.

**Effective Recording Span:** More than 140mm (corresponds to ± 50mA output).

**Gain Ranges:** 0.01, 0.05, 0.1, 0.5, 1, 5V/cm, selectable by an outer dial.

**Gain VERNIER:** Continuously adjustable for intermediate ranges.

**Gain Accuracy:** ± 2% on 0.01V/cm range.

**Gain Temperature Stability:** ± 0.1% of effective recording span/°C (dial set to CAL).

**Input Impedance:** Approx. 150kΩ constant on all ranges (more than 20kΩ when input is out of rated voltage, and power switch is at OFF).

**Maximum Allowable Source Resistance:** 1kΩ.

**Frequency Response:** DC to 1.5kHz-3dB.

**Low-Pass Filter (BAND LIMIT):** Cut-off frequency (−3dB) . . . 10, 30, 300Hz (−6dB/octave) or OFF, selectable by an inner dial.

**Zero-Set:** Adjustable over full effective recording span by POSITION adjustor, over full scale on recording chart by galvanometer.

**Zero Drift:** ± 0.1% of effective recording span/°C (dial set to CAL).

**Maximum Rated Input Voltage:** ± 80V peak on 5V/cm range, and at VERNIER set to lowest position.

**Maximum Allowable Input Voltage:** 150V DC or AC.

**Protection Circuits:** Out of input voltage, and galvanometer protection circuits built in.

**Common Mode Rejection:** More than 90dB at DC or line frequency (on 0.01V/cm range, input shorted).

**Common Mode-Crosstalk Rejection:** More than 90dB at DC or line frequency (on 0.01V/cm range, input of both channels shorted).

**Maximum Common Mode Voltage:** 30V AC or 42V DC.

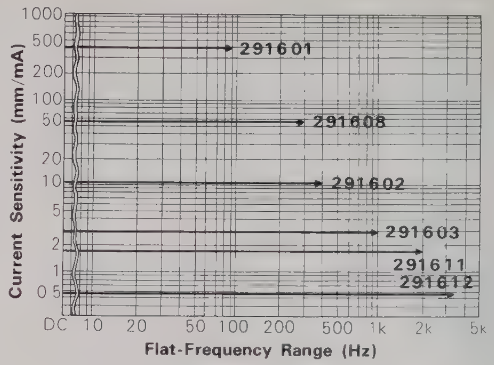
**Maximum Common Mode Voltage between Channels:** 30V AC or 42V DC.

**Calibration Signal:** DC voltage signal corresponds to +40mm on chart (accuracy of calibration signal . . . ± 1% at dial set to CAL, and 23±3°C).

## GALVANOMETERS FOR 2931 & 2932

### Notes for Selection of Galvanometers

- High-frequency galvanometers are required for recording fast-changing variables such as vibrations and transient phenomena.
- A high-sensitivity galvanometer is required for measuring small signals. However, this type of galvanometer is restricted in its maximum allowable current. Therefore, the galvanometer should be protected from burning out as a result of an accidental overload.
- Particular attention should be paid to frequency characteristics, since sensitivity can be amplified by an external amplifier, while frequency response is determined only by the characteristics of the galvanometer itself.
- An electromagnetically-damped type galvanometer will impair recording fidelity unless connected to an external electromagnetic damping resistor.
- Oil-damped galvanometers, of rugged construction and immune to mechanical vibration, are most suitable for measurements in a vibrating environment such as in vehicle travel tests.



*Galvanometer (actual size)*

### Types Available

| Galvanometer Code | Natural Frequency (Hz) | Flat (5%) Frequency Range (Hz) | Coil Resistance (Ω) | External Damping Resistance (Ω) | Sensitivity (Optical Arm: 330mm) (μA/mm) | Maximum Safe Current (mA) |
|---|---|---|---|---|---|---|
| **291601** | 170 | 100 | 22 | 17 | Approx. 4.5 | 1 |
| **291602** | 1,000 | 400 | 27 | Oil damped | Approx. 160 | 50 |
| **291603** | 2,500 | 1,000 | 27 | Oil damped | Approx. 630 | 100 |
| **291608** | 600 | 300 | 30 | Oil damped | Approx. 34 | 10 |
| **291611** | 4,000 | 2,000 | 30 | Oil damped | Approx. 1,400 | 100 |
| **291612** | 7,000 | 3,500 | 30 | Oil damped | Approx. 3,800 | 100 |

Specify codes and quantity desired when ordering.

## SPARES

| Code | Name and Description | | Photocorder Model |
|---|---|---|---|
| **B9496BB** | Recording Paper | KODAK Roll Paper (127 mm x 45.7 m) | **2931** |
| **B9496BE** | | ORIENTAL Roll Paper (127 mm x 35 m) | |
| **B9464AF** | | ORIENTAL Z-fold Paper (127 mm x 30 m) | |
| **B9464AG** | | ORIENTAL Z-fold Paper (127 mm x 60 m) | |

| Code | Name and Description | | Photocorder Model |
|---|---|---|---|
| **B9496GB** | Recording Paper | ORIENTAL Z-fold Paper (178 mm x 60 m) | **2932** |
| **B9496GD** | | ORIENTAL Z-fold Paper (178 mm x 30 m) | |
| **A9052EH** | Mercury Vapour Lamp | USHIO | **2931, 2932** |
| **A9071EH** | | OSRAM | |
| **A9036EH** | USHIO Timing Lamp | | |

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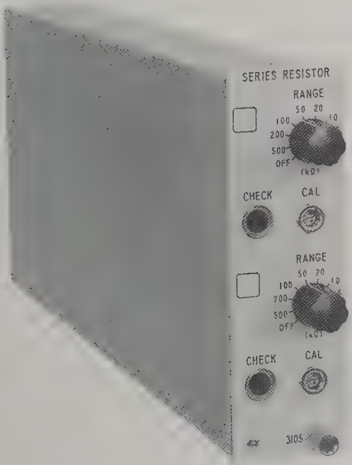
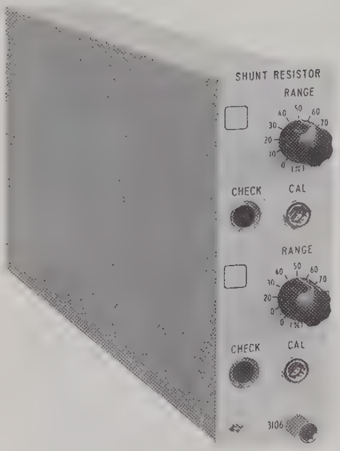
# 3105, 3106
# Series Resistor & Shunt Resistor



*3105*
138 x 42 x 322 mm 1.6 kg
(5-1/2 x 1-5/8 x 12-3/4'' 3.5 lbs)



*3106*
138 x 42 x 322 mm 1.5 kg
(5-1/2 x 1-5/8 x 12-3/4'' 3.3 lbs)

### 3105 SERIES RESISTOR
### (for high voltage measurement to 200V)

3105 is used for extending the voltage measuring range of the Photocorder to 200V. This unit divides such a large voltage which cannot be applied directly to the Photocorder galvanometer. This unit is provided with a simple calibration circuit to calibrate the deflection on the recording paper through the use of an accurate external reference voltage source, such as YEW DC voltage/current standard.

### 3106 SHUNT RESISTOR
### (for large current measurement to 5A)

3106 is used for extending the current measuring range to 5A to facilitate the direct reading of large current waveforms. This is an accessory unit for oscillographs (Photocorders), and most widely used in combination with 3105 Series Resistor. Two independent channels are included in one unit. A simple calibration circuit is provided with this unit.

## SPECIFICATIONS

### 3105

**Number of Channels:** 2.

**Rated Resistance:** 1/2/5/10/20/50/100/200/500kΩ and OFF.

**Accuracy:** ±1% of setting.

**Current Limit:** Less than 200V (rms) for more than 5kΩ, less than 40mA (rms) for less than 5kΩ.

**Insulation Resistance:** More than 100MΩ at 500V DC between input terminals and case.

**Dielectric Strength:** 500V AC (rms) for one minute between input terminal and case.

**Housing:** No housing required for single unit as each unit has an inner housing. Modular cases and mobile rack are available for combination mounting.

**Optional Accessory:** A9041YF(319902) Calibration cord.

### 3106

**Number of Channels:** 2.

**Rated Resistance:** 0.2Ω (selectable from 0 to 100% in 10 steps).

**Accuracy:** ±1% of setting.

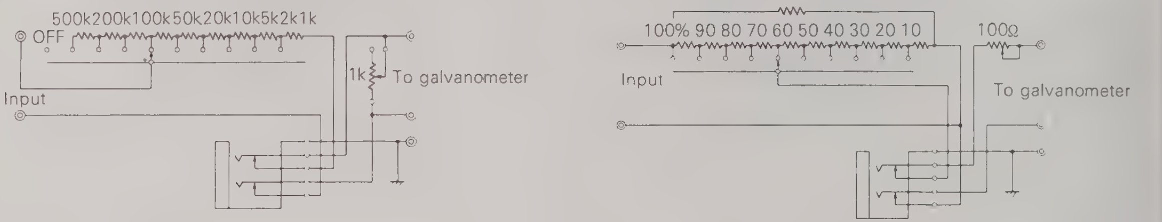
**Current Limit:** Less than 5A (rms).

**Insulation Resistance:** More than 100MΩ at 500V DC between input terminal and case.

**Dielectric Strength:** 500V AC (rms) for one minute between input terminal and case.

**Housing:** No housing required for a single unit as each unit has an inner housing. Modular cases and mobile rack are available for combination mounting.

**Optional Accessory:** A9041YF(319902) Calibration cord.



3105

3106

Circuit Diagram

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# 3131, 3132 & 3133 DC Amplifiers

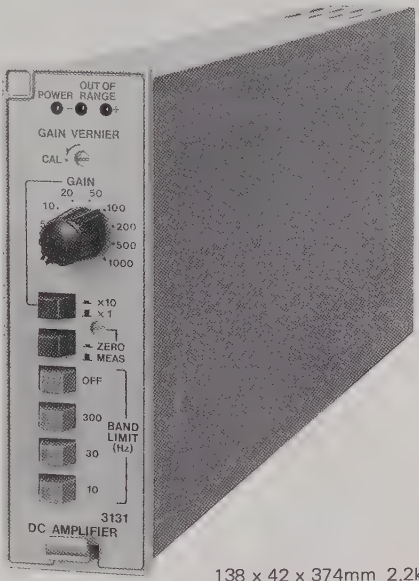
## 3131

Type 3131 is a high-sensitivity, isolation amplifier using photocouplers, pulse width modulator and demodulator. It provides up to 10,000 of gain over a wide frequency range from DC to 5kHz.

Type 3131 combines high stability and versatility with simple operation. Sensitivity is adjustable for 13 ranges from the front panel, via 10-position GAIN dial and push-button GAIN selector.

This instrument is particularly convenient for use with direct recording oscillographs, analog recorders, data recorders as well as digital and analog measuring systems.

- **Output linearity — ±0.05% of full scale**
- **Sensitivity multipliers (GAIN) selectable up to 10,000**
- **Gain accuracy — ±0.1% or ±0.2%**
- **Isolated input-output circuits**
- **High stability**



138 x 42 x 374mm 2.2kg
(5-1/2 x 1-5/8 x 14-3/4" 4.9 lbs)

### SPECIFICATIONS

**Number of Channels:** 1.

**Type:** Isolation amplifier using pulse width modulator.

**Input Circuit:** Floating and guarded.

**GAIN Ranges (Sensitivity Multipliers):** 1 to 10,000 selectable in 13 ranges using a 10-position GAIN dial (1, 2, 5, 10, 20, 50, 100, 200, 500, 1,000) and a push-button GAIN selector (x 1 or x 10).

**GAIN VERNIER:** x 1 (CAL) to approx. x 2.5 of gain range (continuously adjustable).

**Gain Accuracy:** ±0.1% on gain ranges of (1 to 1,000) x 1, ±0.2% on gain ranges of (1 to 1,000) x 10 at an ambient temperature of 23±3°C, after full-scale adjustment at gain 1. (Excludes non-linearity).

**Gain Temperature Stability:** ±0.01% of full scale/°C (GAIN VERNIER set to CAL).

**Output Linearity:** ±0.05% of full scale.

**Input Impedance:** Approx. 10MΩ (approx. 5kΩ when input is out of rated voltage, or power switch is at OFF).

**Frequency Response:** DC to 5kHz$^{+1}_{-3}$ dB.

**Low-Pass Filter (BAND LIMIT):** Cut-off frequency (−3 dB) . . . 10, 30, 300Hz (−6 dB/octave) or OFF selectable by push-button.

**Maximum Output:** ±10V/±50mA (automatically protected at approx. ±70mA).

**Output Impedance:** Less than 0.1Ω.

**Settling Time:** Within 2 ms (the time required to attain a value within ±0.1% of final output at GAIN 1 against an input voltage variation of ±10V).

**Maximum Input Voltage:** 50V DC or AC (sine wave).

**Rated Input Voltage:** ±10V peak.

**Maximum Operating Common Mode Voltage:** 250V AC.

**Zero Drift (Referred to Input):** ±(2 + 1,000/GAIN)μV/°C (GAIN VERNIER set to CAL).

**Output Noise (Referred to Input):** Less than (6 + 2,000/GAIN) μVrms (BAND LIMIT set to OFF).

**Common Mode Rejection:** More than 120 dB for source resistance of 350Ω unbalance, or more than 110 dB for source resistance of 1kΩ unbalance at DC to 60Hz, and GAIN 10,000

**Insulation Resistance:** More than 50MΩ at 250V DC between input-guard and output-ground terminals.

**Dielectric Strength:** 1,500V AC for one minute between input-guard and output-ground terminals.

**Operating Temperature Range:** 5 to 40°C (41 to 104°F).

**Humidity Range:** 20 to 85% relative humidity.

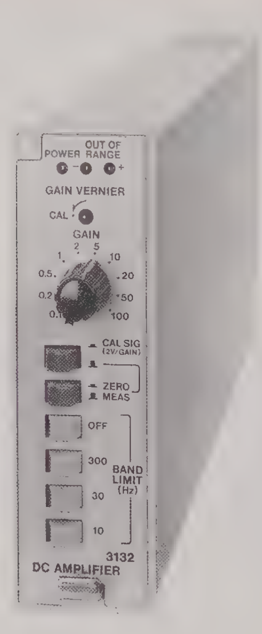
**Power Requirements:** 100, 120, 200, 220 or 240V AC ±10% (must be specified), for both 50 and 60Hz.

**Power Consumption:** Approx. 6.6VA max.

**Accessories supplied at no extra cost:**
Input cord (1.5m) . . . 1 set, power cord (2- or 3- prong type) . . . 1 set, fuse . . . 1 pc.

**Remarks** The specifications described above shall be applied after warm-up time of one hour, and at source resistance of less than 1kΩ.

# 3132



138 x 42 x 374mm 1.9kg
(5-1/2 x 1-5/8 x 14-3/4" 4.2 lbs)

Type 3132 is a general-purpose, isolation amplifier using photocouplers, pulse width modulator and demodulator. It provides up to 100 of gain over a frequency range from DC to 5kHz.

Type 3132 combines high isolation capabilities, stability and linearity with simple operation — gain stability of ±0.03%/°C, output linearity of ±0.05% of full·scale. Sensitivity is adjustable for 10 ranges via 10-position GAIN dial, and a low-pass filter can be selected for 3 ranges by pushbuttons.

- **Complete isolation through photocouplers and YEW-original pulse width modulator**
- **Output linearity — ±0.05% of full scale**
- **10 gain ranges (sensitivity multipliers), dial-selectable from 0.1 up to 100**
- **Gain accuracy — ±0.3%**
- **Gain stability — ±0.03% of full scale/°C**
- **Frequency ranges from DC to 5kHz**
- **Pushbutton-selected filtering (BAND LIMIT) of 10, 30 and 300Hz**
- **Red LED out-of-range indication**
- **Calibration signal output**

## SPECIFICATIONS

**Number of Channels:** 1.

**Type:** Isolation amplifier using pulse width modulator.

**Input Circuit:** Floating and guarded.

**GAIN Ranges (Sensitivity Multipliers):** 0.1 to 100 selectable in 10 ranges using a 10-position GAIN dial (0.1, 0.2, 0.5, 1, 2, 5, 10, 20, 50, 100).

**GAIN VERNIER:** x 1 (CAL) to approx. x 2.5 of gain range (continuously adjustable).

**Gain Accuracy:** ±0.3% at an ambient temperature of 23±3°C, after full-scale adjustment at GAIN 1 (excludes non-linearity).

**Gain Temperature Stability:** ±0.03% of full scale/°C (GAIN VERNIER set to CAL).

**Output Linearity:** ±0.05% of full scale (GAIN VERNIER set to CAL).

**Input Impedance:** Approx. 1MΩ constant (more than 90kΩ when input is out of rated voltage, or power switch is at OFF).

**Frequency Response:** DC to 5kHz$^{+1}_{-3}$ dB.

**Low-Pass Filter (BAND LIMIT):** Cut-off frequency (−3dB) . . . 10, 30, 300Hz (−6 dB/octave) or OFF push-buttons.

**Maximum Output:** ±10V/±50mA (automatically short circuit protected at approx. ±70mA).

**Output Impedance:** Less than 0.2Ω at DC.

**Calibration Signal Output:** +2.0V x GAIN VERNIER (accuracy of calibration signal . . . ±0.5% at GAIN VERNIER set to CAL, and 23±3°C).

**Settling Time:** Within 0.5 ms (the time required to attain final output of ±30mV at GAIN 1, BAND LIMIT set to OFF, against an output voltage variation of 10V).

**Maximum Input Voltage:** 250V DC or AC (sine wave).

**Rated Input Voltage:** ±100V peak.

**Maximum Operating Common Mode Voltage:** 250V AC.

**Zero Drift (Referred to Output):** ±1.5mV/°C on GAIN 0.1, 0.2, 1, 2, 10 or 20, ±2mV/°C on GAIN 0.5, 5, 50, ±3mV/°C on GAIN 100 (GAIN VERNIER set to CAL).

**Output Noise (Referred to Output):** Less than 2mVrms (from 10Hz to 10MHz, BAND LIMIT set to OFF).

**Common Mode Rejection:** More than 110dB for source resistance of 10kΩ unbalance, at DC or 60Hz, and GAIN 100.

**Insulation Resistance:** More than 50MΩ at 250V DC between input, guard and output, ground terminals, or between output terminals, power line and ground terminal.

**Dielectric Strength:** 1,500V AC for one minute between input, guard and output, ground terminals, or between output terminals, power line and ground terminal.

**Operating Temperature Range:** 5 to 40°C (41 to 104°F).

**Humidity Range:** 20 to 80% relative humidity.

**Power Requirements:** 100, 120, 200, 220 or 240V AC ±10% (must be specified), 48 to 63Hz.

**Power Consumption:** Approx. 6VA max.

**Accessories supplied at no extra cost:**
Input cord (1.5m) . . . 1 set, power cord (2- or 3-prong type) . . . 1 set, stand adaptor for desk-top use . . . 1 pc., flat tip for guard terminal . . . 1 pc., fuse . . . 1 pc.

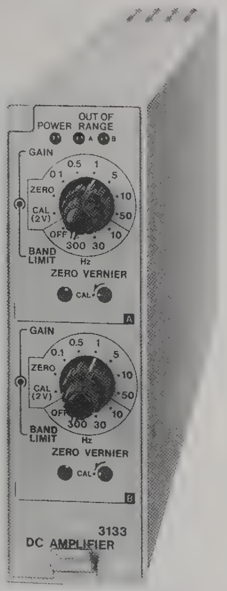
**Remarks** The specifications described above shall be applied after warm-up time of one hour, and source resistance of less than 1kΩ.

# 3133

Type 3133 is a general-purpose, direct-coupled DC amplifier having two channels. Inputs of both channels are fully floating, and the instrument has a frequency range from DC to 20kHz with a maximum gain of 50.

Type 3133 provides high linearity (±0.05% of full scale) and versatility including built-in low-pass filters, zero set of ±100%, calibration signal output, and out-of-range indicators for both channels. In addition, Type 3133 offers full front panel operation, featuring easy-to-use, dual control dial.

- **Two floating channels in one compact package**
- **Output linearity — ±0.05% of full scale**
- **Wide frequency response — DC to 20kHz$^{+}_{-}\frac{1}{3}$ dB**
- **Calibration signal output**
- **Selectable filtering (BAND LIMIT) — 10, 30 and 300Hz for both channels**
- **Zero-set adjustable over full scale**
- **6 gain ranges from 0.1 to 50**
- **Out of range indicators for both channels**
- **Simple operation using two-in-one control dial**



138 x 42 x 374mm 2.2kg
(5-1/2 x 1-5/8 x 14-3/4" 4.9 lbs)

## SPECIFICATIONS

**Number of Channels:** 2.

**Type:** Direct-coupled DC amplifier (floating between channels).

**Input Circuit:** Unbalanced, floating and guarded.

**GAIN Ranges (Sensitivity Multiplier):** 0.1 to 50 selectable in 6 ranges using an outer GAIN dial (0.1, 0.5, 1, 5, 10, 50).

**Gain VERNIER:** x 1 (CAL) to approx. x 5 of gain range (continuously adjustable.)

**Gain Accuracy:** ±3% at an ambient temperature of 23±3°C, after full-scale adjustment at GAIN 1 (excludes non-linearity).

**Gain Temperature Stability:** ±0.05% of full scale/°C (VERNIER set to CAL).

**Output Linearity:** ±0.05% of full scale (VERNIER set to CAL).

**Input Impedance:** Approx. 150kΩ constant (more than 24kΩ when input is out of rated voltage, or power switch is at OFF).

**Frequency Response:** DC to 10kHz$^{+}_{-}\frac{1}{3}$dB, or DC to 20kHz$^{+}_{-}\frac{1}{3}$dB for output voltage of within ±5V peak (VERNIER set to CAL).

**Low-Pass Filter (BAND LIMIT):** Cut-off frequency (—3 dB) . . . 10, 30, 300Hz (—6dB/octave) or OFF selected using inner dial.

**Zero-Set:** Adjustable over full scale.

**Maximum Output:** ±10V/±50mA (automatically short circuit protected at approx. ±70mA).

**Output Impedance:** Less than 0.2Ω at DC.

**Calibration Signal Output:** +2.0V x gain VERNIER (accuracy of calibration signal . . . ±1% at VERNIER set to CAL, and 23±3°C).

**Settling Time:** Within 100μs (the time required to attain final output of ±10mV, at GAIN 1, BAND LIMIT set to OFF, against an output voltage variation of 10V).

**Maximum Input Voltage:** 150V DC or AC (sine wave).

**Rated Input Voltage:** ±100V peak.

**Zero Drift:** ±0.1% of full scale/°C (VERNIER set to CAL).

**Output Noise (Referred to Output):** Less than 2mVrms (from 10Hz to 10MHz, VERNIER set to CAL).

**Crosstalk Rejection between Channels:** More than 60dB at DC to 20kHz (at input of within ±10V/±50mA, input of A or B channel shorted, GAIN 50, and VERNIER set to CAL).

**Common Mode Rejection:** More than 90dB at DC or 60Hz (GAIN 50, input shorted, and L and ground terminals of A or B channel connected).

**Common Mode-Crosstalk Rejection:** More than 90dB at DC or 60Hz (GAIN 50, input shorted, and L and ground terminals of A or B channel connected.

**Maximum Common Mode Voltage:** 30V AC or 42V DC.

**Insulation Resistance:** More than 50MΩ at 250V DC between input (channels A and B) and ground terminals, or between input terminals (channels A and B).

**Dielectric Strength:** 250V AC for one minute between input (channels A and B) and ground terminals, or input terminals (channels A and B), or 1,500V AC for one minute between power line and ground terminal.

**Operating Temperature Range:** 5 to 40°C (41 to 104°F).

**Humidity Range:** 20 to 85% relative humidity.

**Power Requirements:** 100, 120, 220 or 240V AC ±10% (must be specified), 48 to 63Hz

**Power Consumption:** Approx. 10VA max.

**Accessories supplied at no extra cost:**
Input cord (1.5m) . . . . 1 set, power cord (2- or 3-prong type) . . . 1 set, stand adaptor for desk-top use . . . 1 pc., flat tip for guard terminal . . . 1 pc., fuse . . . 1 pc.

**Remarks** The specifications described above shall be applied after warm-up time of one hour, and at source resistance of less than 1kΩ.

## OPTIONAL ACCESSORIES FOR 3131, 3132 & 3133

**Modular Cases**

| Model | Name | Number of DC amplifiers to be housed |
|---|---|---|
| **319733** | Portable half-size modular case | Up to 5 |
| **319743** | Portable & rack-mounting full-size modular case | Up to 10 |
| **319904** | Blank panel | – |

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# 3134
# Strain Amplifier

The YEW Model 3134 is a high-sensitivity, low-noise strain amplifier using an AC bridge. Two different models are available, depending on the method of bridge balance, manual on Model 313401, or automatic on Model 313402. Both models provide high stability, and fast, simple operation, by using a fully electronic circuit. Model 313402 senses unbalance and produces opposing balance signal through digital circuit and 2-step comparators.

313401

313402

## MAIN FEATURES

- **Automatic bridge balance using digital circuit (313402)**
  Model 313402 accomodates the automatic bridge balance feature, which provides an instantaneous balance at the touch of R. BALANCE selector. Internal 2-step comparators cancel residual gage unbalance.
- **Automatic C balance (313401, 313402)**
  The fully electronic feedback circuit automatically sequences to select the correct balance capacitance.
- **High sensitivity — 0.5V output for $10 \times 10^{-6}$ strains**
  High sensitivity, excellent noise performance and zero drift are particularly convenient to use in low-level strain measurement.
- **Isolated input-output circuits**
- **0.2% linearity**
- **Selectable filtering (BAND LIMIT) — 10, 30, 100, 300Hz or OFF**

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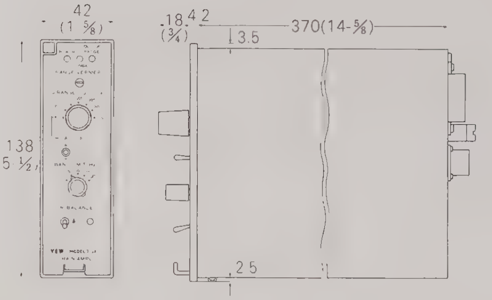
## SPECIFICATIONS

**Gage Factor:** 2.00.
**Gage Resistance:** 120 to 1,000Ω.
**Bridge Voltage:** 0.5, 2V.
**Bridge Frequency:** 5kHz ±5%.
**Bridge Balance Control Range:** Resistance ... ±1%, capacitance ... ±2,000pF (120Ω), ±700pF (350Ω).
**Bridge Balance Method:** Capacitance ... automatic by fully electronic circuit, resistance ... automatic, digital, by fully electronic circuit (**313402**), or manual (**313401**).
**Maximum Sensitivity:** 0.5V/10 x $10^{-6}$ strains.
**Output Voltage:** ±10V/50mA.
**Output Impedance:** Less than 0.2Ω.
**Measuring Range:** 0 to ±200, 500, 1,000, 2,000, 5,000, 10,000 x $10^{-6}$ strains.
**Calibration Strain:** ±(measuring range x 0.5).
**Calibration Strain Accuracy:** ±0.5%.
**Range Vernier:** x 1 to approx. 1/3 of range.
**Frequency Response:** DC to 2,000Hz +1dB, −3dB.
**Linearity:** Within ±0.2% of full scale.
**Drift with Temperature:** Within ±0.1 x $10^{-6}$ strains/°C.
**Drift with Time:** Within ±1.0 x $10^{-6}$ strains/8 hours (**313401**), or within ±0.5 x $10^{-6}$ strains/8 hours (**313402**) after 15-minute warmup.
**Line Regulation:** Within ±0.05% against a power line voltage variation of 100V ±10%.
**Sensitivity:** Within ±0.03%/°C, within ±0.2%/8 hours after 15-minute warmup.
**Signal-to-Noise Ratio:** More than 46dB (rms).
**Low-Pass Filter (BAND LIMIT):** Cut-off frequency ... 10, 30, 100, 300Hz (−12dB/octave) or OFF.
**Dielectric Strength:** 1,500V AC for one minute between power line and ground terminal, 250V AC for one minute between input. output (except output L) and ground terminals, or between input and output terminals.
**Operating Temperature Range:** 5 to 40°C (41 to 104°F).
**Humidity Range:** 20 to 80% relative humidity.
**Storage Temperature Range:** −10 to 60°C (14 to 140°F).
**Power Requirements:** 100, 120, 200, 220 or 240V AC (must be specified), 48 to 63Hz.
**Power Consumption:** Approx. 8VA (**313401**), 12VA (**313402**).
**Dimensions:** Approx. 138 x 42 x 374mm (5-1/2 x 1-5/8 x 13-3/4").
**Weight:** Approx. 2.2kg (4.9 lbs).
**Accessories supplied at no extra cost:** **319301** bridge head with 5m cord ... 1 set, output connector plug ... 1 pc., power cord ... 1 set, fuses ... 2 pcs.

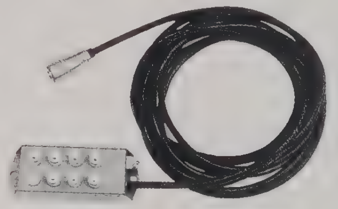
## DIMENSIONS

Unit: mm (approx. inch)



**313402**

(**313401** has the same external dimensions except for the front panel arrangement)



*319301*

## OPTIONAL ACCESSORIES FOR 3134

**Modular Cases**

| Code | Name | Number of **3134** to be housed |
|---|---|---|
| **319733** | Portable half-size modular case | Up to 5 |
| **319743** | Portable & rack-mounting full-size modular case | Up to 10 |
| **319904** | Blank panel | – |

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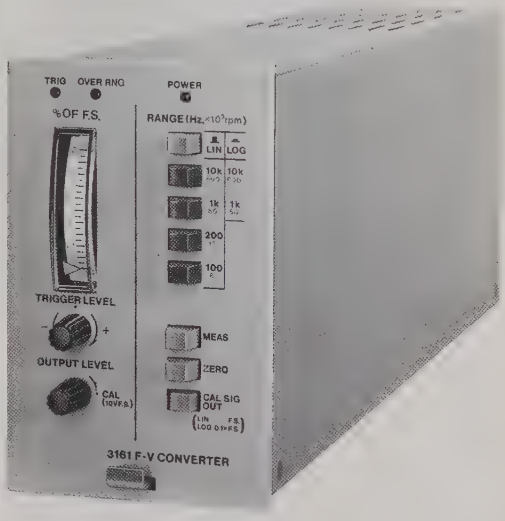
# 3161 & 3142
# Converters

## 3161 F-V CONVERTER

The Type 3161 F-V Converter is a versatile frequency (rotational speed)-to-voltage converter that converts input frequencies to DC vlotage or current in four ranges on the linear conversion mode, or in two ranges on the log conversion mode. The continuous recording or monitoring of frequencies, rotational speeds, or vibration is possible when combined with a recording instrument. Using optional photoelectric probe, Type 3161 allows rotational speed measurement without need to touching the rotating object.



138 x 84 x 374mm 3.0kg
(5-1/2 x 3-3/8 x 14-3/4" 6.6 lbs)

### SPECIFICATIONS

**Input Frequency Range:** 0.1Hz to 10kHz (6 to 600,000 rpm).

**Input Impedance:** More than 100kΩ.

**Maximum Full Scale Input:** ±100V.

**Input Sensitivity:** More than 0.5Vp-p.

**Trigger Level Adjustable Range:** Approx. –5 to +5.

**Minimum Input Pulse Width:** 50µs.

**Output Voltage:** 10V DC/full scale (continuously adjustable from 10 to 100% of full scale), load current . . . 1mA max.

**Output Current:** 50mA DC/full scale (continuously adjustable from 10 to 100% of full scale), load resistance . . . . . less than 60Ω.

**Monitoring Meter:** Class 2.5.

**Effect of Power Supply Voltage Fluctuations:** Within 0.1% of range at power supply voltage fluctuation of 100V± 10%.

**Dielectric Strength:** 1,500V AC for one minute between power line and case.

**Insulation Resistance:** More than 100MΩ at 500V DC between power line and case.

**Operating Temperature Range:** 5 to 40°C (41 to 104°F).

**Humidity Range:** 20 to 80%, relative humidity.

**Warmup Time:** Approx. 20 minutes (to attain the value within rated accuracy).

**Power Requirements:** 100, 120, 200, 220 or 240V AC± 10% (must be specified), 50 and 60 Hz.

**Power Cunsumption:** 14VA max. (Type 3161 only), 18VA max. (using an optional Type 261810 photoelectric probe).

**Accessories supplied at no extra cost:** Power cord (2- or 3-prong type) . . . 1 set, Fuse . . . 1 pc., Measurement lead . . . 1 set.

| **Conversion Mode** | | Linear Mode | | | | Log Mode | |
|---|---|---|---|---|---|---|---|
| **Rated frequency range** | | 100Hz<br>(6,000 rpm) | 200Hz<br>(12,000 rpm) | 1kHz<br>(60,000 rpm) | 10kHz<br>(600,000 rpm) | 1kHz<br>(60,000 rpm) | 10kHz<br>(600,000 rpm) |
| **Frequency measring range** | | 0.1 to 100Hz<br>(6 to 6,000 rpm) | 0.2 to 20Hz<br>(12 to 12,000 rpm) | 1Hz to 1kHz<br>60 to 60,000 rpm) | 10Hz to 10kHz<br>(600 to 600,000 rpm) | 0.1Hz to 1kHz<br>(6 to 60,000 rpm) | 1Hz to 10kHz<br>(60 to 600,000 rpm) |
| **Response** | | 1 cycle | | 10 cycles | 100 cycles | Within 4 cycles | Within 40 cycles |
| **Accuracy (at 23±3°C)** | **Voltage output** | ±(0.4% of reading + 0.1% of range) | | | | ±(1 dB + 0.1Hz) | |
| | **Current output** | ±(1% of reading + 0.1% of range) | | | | ±(1.5 dB + 0.1Hz) | |
| **Temperature coefficient** | | ±0.05% of range/°C | | | | ±0.1 dB/°C | |
| **Ripple** | | Within 20mVp-p at line Frequency | | | | Within 20mVp-p at line Frequency | |
| **Calibration signal** | | 100Hz | 200Hz | 1kHz | 10kHz | 100Hz | 1kHz |
| **Log conversion gain** | | — | | | | 2.5V/decade | |

# 3142 AC-DC CONVERTER

216 x 89 x 400mm 4kg
(8-1/2 x 3-1/2 x 14-3/4" 8.8 lbs)

## FEATURES

- **Excellent Linearity**
  Within ±1% of rated output value.
- **Quick Response** — within 0.5 second.
- **Highly Sensitive**
  More than 5 cm/10 mV (rms) on recording paper of YEW X-Y Recorder.
- **Adjustable Sensitivity (Recording Width)**
- **Balanced, Floating Input**

This unit uses a half-wave rectification system using diodes to convert 30 Hz to 20 kHz sinusoidal waves to DC current or voltage, so that the AC voltage can be recorded by YEW photocorders or recorders.

## SPECIFICATIONS

**Rectification Method:** Half-wave rectification (mean value).
**Input Voltage Measuring Range:** RMS sine wave

| Measuring Range | 10mV/cm | 25 | 50 | 100 | 250 |
|---|---|---|---|---|---|
| Max Input Voltage | 0.2V | 0.5 | 1 | 2 | 5 |

| Measuring Range | 0.5V/cm | 1 | 2.5 | 5 | 10 | 20 |
|---|---|---|---|---|---|---|
| Max. Input Voltage | 10 | 20 | 50 | 100 | 200 | 250 |

Upper ranges stand for 10mm deflection of pen recorder (with 0.5mV/cm sensitivity).

**Frequency Range:** 30 Hz to 20 kHz (output deviation . . . ±1% of rated output).

**Linearity:** ±1% of rated output.

**Input Impedance:** approx. 100 kΩ; Capacity of less than 50 pF.

**Output Indicator:** Scale division; 0 to 15 mV to 1.5 mA (Double scale. Sensitivity; 100 μA).

**Operating Temperature Range:** 0 to 45°C (32 to 113°F).

**Influence of Power Supply Variation:** Output variation is within ±0.5% against power supply variation of 100 ±10 V.

**Power Requirements:** 100, 115, 210, 220 or 230V AC ±10%, 50 or 60 Hz (must be specified), other voltages available upon request.

**Power Consumption:** Approx. 7 VA.

**Accessories supplied at no extra cost:** Power cord . . 1 pc.,
Fuse . . . . . . . 2 pcs.

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# 3458
# Signal Conditioner

188 x 52 x 413mm 2.5kg
(7-3/8 x 2-1/8 x 16-1/4'' 5.5 lbs)

The Model 3458 Signal Conditioner is a high-performance signal conditioning unit, which is used with an analog recorder, electromagnetic oscillograph, data recorder, digital data processing system and oscilloscope as a stable preamplifier.

Model 3458 is especially suited for precision strain measurement with quick, exact calibration and bridge balancing, when combined with a strain gage, various types of strain-gage transducers (load cell, pressure transducer, displacement transducer, torque meter, etc.), slide-resistance transducer, and Bridge Head (standard accessary).

With the R balance selector set to OFF, Model 3458 can also be used as high-sensitivity differential DC amplifier (data amplifier).

## MAIN FEATURES

- **Suitable for high-precision strain measurement (Also usable as differential DC amplifier)**
- **High linearity — ±0.01% of full scale**
- **Low drift — ±1.5 $\mu$V/°C**
- **Constant gage-voltage mode/linerar mode selection**
- **Built-in low-pass filter**
  Selectable for 10Hz, 30Hz, 300Hz, 3kHz, OFF
- **Remote control of calibration possible**

## GENERAL SPECIFICATIONS

**Operating Temperature Range:** 5 to 40°C (41 to 104°F).

**Operating Humidity Range:** 20 to 80%, relative humidity.

**Storage Temperature Range:** –25 to 70°C (–13 to 158°F).

**Storage Humidity Range:** 5 to 95%, relative humidity.

**Power Requirements:** 100V AC±10%, 48 to 62Hz (other power supply voltages are available upon request).

**Power Consumption:** Approx. 4VA at no load, approx. 6VA at rated load.

**Dielectric Strength:** 1,000V AC for one minute between power line and case, 200V AC for one minute between control common and case, and between control common and analog output common, 15V AC and DC for one minute between H(high) and L(low) terminals, and (G) grounding terminals.

**Accessories supplied at no extra cost:** 319300 bridge head . . . 1 pc., power cord . . . 1 set, fueses (1A) . . . 2 pcs., input plug . . . 1 set, output control plug . . . 1 set.

**Optional Accessories:** **319401** portable full-size modular case, **319402** rack-mounting full-size modular case.

## SPECIFICATIONS

### BRIDGE CONTROL SECTION

**Type of Wiring:** 4-wire remote sensing method.

**Bridge Voltage:** 1, 2, 5, 10V DC, ±(0.05% of setting + 1mV) at 23±5°C.

**Bridge Voltage Regulation:** ±0.05% for 0 to 50mA load variation, 90 to 110V line voltage variation, or 0 to 10Ω cable resistance variation.

**Bridge Voltage Time Stability:** ±0.03%/10 days at 23±1°C.

**Bridge Voltage Temperature Stability:** ±0.01%/°C.

**Bridge Voltage Ripple:** 2mVp-p.

**Max. Bridge Current:** 50mA (limited to approx. 80mA for short protection).

**Bridge Balance Control Range and Resolution:**

| Bridge Balance Control Range | Resolution |
|---|---|
| ±1% | 5 x $10^{-6}$ strains |
| ±0.1 | 1 x $10^{-6}$ strains |
| OFF | — |

1. Percent in balance control range is a deviation rate of bridge resistance from reference value.
2. A balance control range of 1% corresponds to 5mA unbalanced at 2V bridge voltage.

**Gage Factor:** 2.00 (fixed).

**Gage Resistance:** 120Ω to 1kΩ (bridge current is limited to 50mA).

**Calibration Strain:** 0, ±1,000, ±2,000, ±4,000, ±6,000 x $10^{-6}$ strains.

The calibration strain is not affected by bridge voltage ($V_B$) or gage resistance.

Calibration strain is equivalent to amplifier input level of: 0/±500 x $V_B$/±1,000 x $V_B$/±2,000 x $V_B$/±3,000 x $V_B$ (μV).

**Calibration Strain Accuracy:** ±(0.1% of setting + 3 x $10^{-6}$ strains).

**Remote Calibration:** CAL ZERO (Bridge voltage is adjusted to zero), CAL SET (Calibration signal is provided in accord with set position of CAL SET selector).

Calibration (remote control) by relay contact or TTL logic signal.

### AMPLIFIER SECTION

**Type:** Direct-coupled DC amplifier.

**Type of Input:** Differential.

**Gain Adjustment:** Gain range . . . 100, 200, 500, 1,000 (4 ranges), Gain vernier: x 1 to approx. x 3 of gain range (continuously adjustable).

**Measuring Range:** DC voltage . . . 0 to ±10mV, 20mV, 50mV, 100mV, Strain; 0 to ±100,000, 50,000, 20,000, 10,000 x $10^{-6}$ strains at bridge voltage of 2V.

**Max. Sensitivity:** (at gain vernier x 1). DC voltage . . . 10mV, 10V, output, Strain . . . 10,000 x $10^{-6}$ strains/10V output.

**Gain Accuracy:** ±0.15% at 23±5°C (gain vernier set to off).

**Gain Temperature Stability:** ±0.01%/°C.

**Frequency Response:** 3dB for DC to 10kHz (at output of less than ±10V), −3dB for DC to 20kHz (at output of less than ±5V).

**Low-Pass Filter (Band Limit):** Cut-off frequency . . . 10Hz, 30Hz, 300Hz, 3kHz, OFF.

**Output:** Max. output voltage . . . ±10V, Max. output current . . . ±50mA, Output impedance . . . Less than 0.1Ω (80mA "short" limiting protection circuit).

**Linearity (DC):** Within ±0.01% of full scale.

**Noise:** (gain multiplier x 1,000, input shorted, and frequency range of 0.1Hz to 500kHz), 4μVp-p at Band Limit of 30Hz, 8μVp-p at Band Limit of 300Hz, 16μVp-p at Band Limit of 3kHz, 6μ Vrms at Band Limit of OFF.

**Input Impedance:** Normal mode . . . Approx. 10MΩ, Common mode; Approx. 100MΩ.

**Max. Source Resistance:** 1kΩ.

**Max. Input Voltage:** ±15V DC or AC (for both common and normal modes).

**Temperature Coefficient of Offset Voltage:**

$\pm\left(1.4+\dfrac{100}{\text{Gain}}\right)\mu V/^\circ C$ (after one hour of warm-up time).

**Time Stability of Offset Voltage:**

$\pm\left(10+\dfrac{1{,}000}{\text{Gain}}\right)\mu V/10$ days (at 23±1°C, and after one hour of warm-up time).

**Bias Current:** ±6nA at 23±5°C.

**Rated Common Mode Voltage:** ±10V DC or AC (peak value).

**Common Mode Rejection** (DC to 60Hz): 100dB for source resistance of 120Ω balance, 80dB for source resistance of 1kΩ unbalance.

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Printed in Japan Apr [illegible]

# 3655E
## ANALYZING RECORDER

## A Powerful Tool for Waveform Analysis
with full computing capabilities and 4-color plotter.

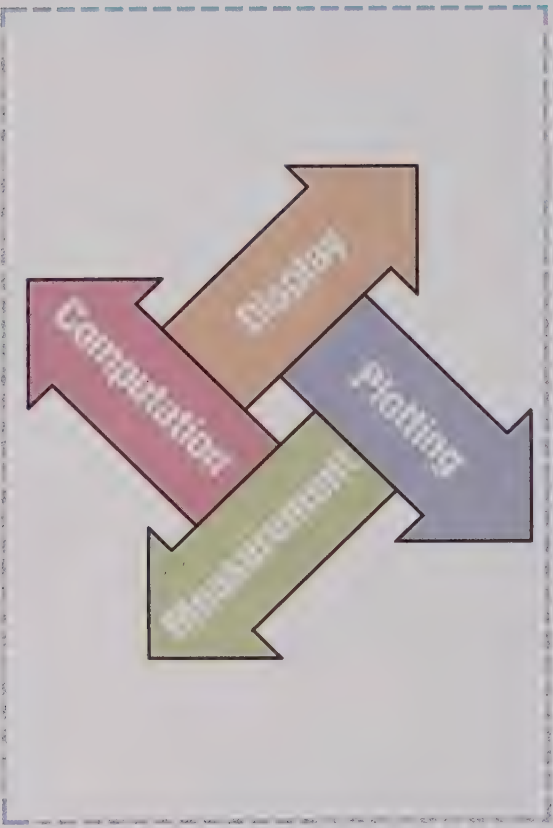
YOKOGAWA
MODEL 3655E ANALYZING RECORDER
CURSOR
TRIGGER
MODEL 3659-10 B DATA MEMORY MODULE
MODEL 3659-20A FFT MODULE

RS-232C
GPIB

**YOKOGAWA**

Bulletin 3655E-E

# Simultaneous measurement, display & plotting of up to 4 channels with powerful computing capability.



The Model 3655E Analyzing Recorder is a powerful new tool with full waveform analysis capabilities. Model 3655E handles up to four channels and digitizes the signals at up to 50 kHz with 14-bit resolution. Based on all-in-one design concept, it includes an easy-to-read 7-inch CRT, four-color plotter, a variety of powerful computing functions in a single package.

## CONVENIENT FEATURES

- **14-bit resolution A-D converter**
- **5 types of TC inputs—especially powerful in analysis of fast-changing temperature signal**
- **8K or 32K words/channel of buffer memory**
- **A variety of powerful computing functions**
  - Each channel or channel-channel — +, −, ×, ÷, square root, logarithm, exponential function, absolute value, 1st and 2nd differentials and integrals, and moving averages.
  - Measured waveforms—integral, max., min., pk-pk, mean and rms.
- **2-channel FFT analysis of 2 Hz to 20 kHz (optional)**
- **X-Y recording of high-speed events**

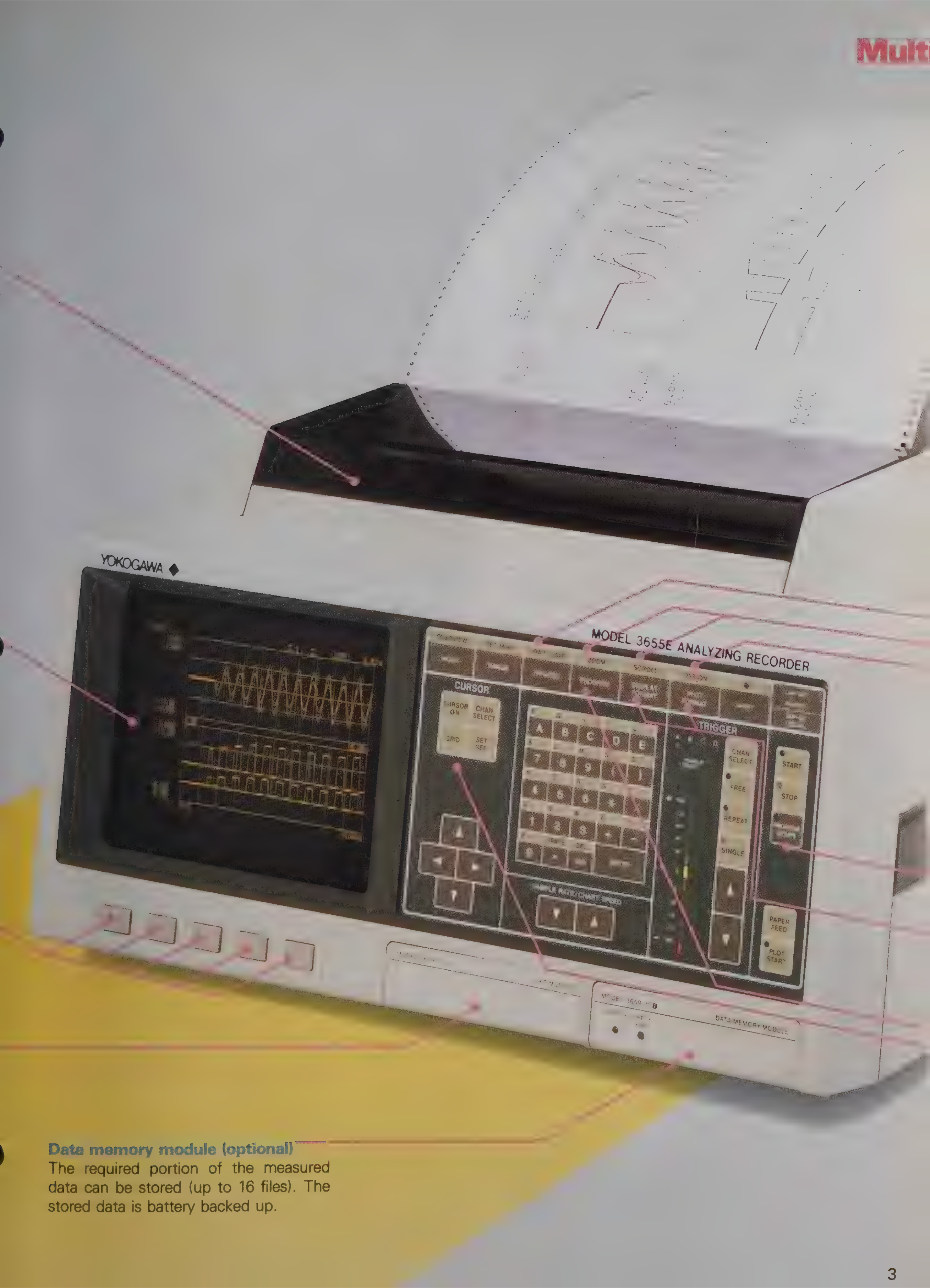
**Crisp, clear 4-color printout by the built-in plotter**
The data displayed on the screen is plotted in four distinctive colors by the built-in plotter. It uses an A4 paper which makes it useful for filing in standard documents.

**Easy-to-read amber colored 7" CRT**
Details of the program and waveforms are clearly displayed on the "easy on the eyes" screen.

**Menu setting keys**
All settings can be easily made through key operation for menu programming on interactive display.

**FFT module (optional)**
Installed in an edge connector slot, this is a module for analyzing one or two channels of FFT.

## Mult



**Data memory module (optional)**
The required portion of the measured data can be stored (up to 16 files). The stored data is battery backed up.

# Specifications

## ANALOG INPUT

### VOLTAGE INPUT

**Measuring Ranges:** ±60, 200, 600 mV, 2, 6, 20, 60 V f.s.

**Max. Allowable Input Voltage:** 130 V (DC + AC pk, frequency 1 kHz max.).

**Input Impedance:** Approx. 1 MΩ.

**Frequency Band (Analog Section):** DC to 20 kHz ($\pm\frac{1}{3}$ dB, DC coupling), 1 Hz to 20 kHz ($\pm\frac{1}{3}$ dB, AC coupling), (DC to 1.5 Hz, −3 dB... real-time mode), at filter OFF.

**Input Coupling:** DC or AC (DC only in real-time mode).

**Type of Input:** Floating (unbalanced), isolated for each channel.

**Input Channels:** Up to 2 or 4.

**Accuracy:** ±0.25% of full scale on 2 V range, ±0.5% of full scale on other ranges, at filter OFF, DC, 23±3°C.

**Temperature Coefficient:** Zero drift... ±0.02% of f.s./°C after auto-calibration, gain... 0.01%/°C at anti-aliasing filter OFF (0.05%/°C at filter ON).

### TEMPERATURE INPUT (not including FFT mode)

**TC Types & Measuring Ranges:** ANSI, JIS (or DIN) model... R (PtRh-Pt); 0 to 1,600°C, K (NiCr-Ni); −200 to 1,300°C, E; −200 to 800°C, J (Fe-CuNi); −200 to 900°C, T (Cu-CuNi); −200 to 400°C.

## A-D CONVERSION

**Resolution:** 14 bits.

**Conversion Speed:** 20 μs.

**A-D Converter:** Provided for each channel (simultaneous measurement of all channels).

## MEMORY MODE

### MEMORY

**Max. Memory Capacity for Each Channel:** 8K or 32K words.

**Data Buffer Memory:** 500, 2K, 8K* words (**3655E□3**), or 500, 2K, 8K, 32K* words (**3655E□4**), *... not including computing or averaging operation.

**Writing Rate:** 20 μs to 1 s/word (15 steps, 1-2-5 sequence), or external clock, parallel writing.

**Timebase Accuracy:** ±0.02%.

**Pre-Trigger:** 0 to 100% (10% steps).

### TRIGGERING

**Trigger Modes:** FREE, RUN, REPEAT, SINGLE.

**Trigger Source:** Internal (CH A, CH B, CH C, CH D) or external (TTL-level); (CH C, CH D for 4-channel model only).

**Trigger Slope:** Rise (_↑‾) or fall (‾↓_).

**Trigger Level:** −100 to +100% (internal, 2% steps), TTL-level (external).

**Averaging:** Linear or exponential averaging (number of averages or attenuation constant selectable from 4, 8, 16, 32, 64, 128, 256).

### FILTER

**Cut-Off Frequency (-3 dB):** 1.5 Hz (line), 50 Hz to 20 kHz (9 steps, anti-aliasing), or OFF.

**Filter Characteristics (Typical):** Line... −50 dB at 50 or 60 Hz, anti-aliasing... 120 dB/oct.

**Pass Band Characteristics (Typical):** Anti-aliasing... ±0.5 dB typical (DC to 1/2 fc; fc... cufoff frequency).

### COMPUTING FUNCTIONS

**Operational Modes:** +, −, ×, ÷, SQR (square root), LOG (logarithm), EXP (exponential function), ABS (absolute value), 1st & 2nd differentials, 1st & 2nd integrals, MEAN (100-point moving average), and Option Key modes.

**Option Key Modes:** Integral, max., min., pk-pk, mean, rms (within cursor range).

### DISPLAY

**Display Format:** Single, dual or X-Y mode.

**Cursor:** Y-T or X-Y waveform data identified by cursor can be displayed in digital.

**Reference Cursor:** Deviation between two points designated by SET REF key can be displayed in digital.

**Zooming:** Vertical or horizontal axis.

**Scroll:** All waveforms zoomed in horizontal can be scrolled in time axis.

**Scaling:** Upper and lower limits can be set in vertical axis.

### PLOTTING

**Plot Formats:** CRT copy, analog, digital or list.

**Title Plotting:** Alphanumeric title of up to 40 characters can be plotted by using programming keys.

**Plotting Area:** A4 size (CRT copy) or designated length by number of words (analog or digital mode).

**Duplex Plotting:** One or more waveforms can be plotted over the initial trace.

**Automatic Plot Start:** Plotting is automatically initiated by the trigger (at non-drying of pen tip).

## REAL-TIME MODE

**Sampling Interval:** 1 s (without computation).

**Operating Functions:** Same as in memory mode (except for MEAN).

**Plotting Size:** 150 mm wide (analog).

**Chart Speeds:** 4 cm/min to 1 cm/h (10 steps).

**CMR (Typical):** 120 dB at 50 or 60 Hz.

**NMR (Typical):** 50 dB at 50 or 60 Hz.

## GENERAL SPECIFICATIONS

**Display Tube:** 7″ CRT (amber).

**Plotter:** Four-color digital plotter using ball-point pens (black, red, green and blue).

**Panel Setting Memory:** Three internal batteries maintain eight programming modes for about 3 months when power is removed.

**Operating Temperature and Humidity Ranges:** 5 to 40°C (41 to 104°F), 40 to 80% R.H.

**Dielectric Strength:** 1,500 V AC for 1 min. between power line and case, 1,000 V AC for 1 min. between input terminal and case.

**Insulation Resistance:** More than 10 MΩ at 500 V DC between power line and case, and between input terminal and case.

**Power Requirements:** 90 to 132 V, or 180 to 250 V AC (must be specified), 48 to 63 Hz.

**Power Consumption:** 240 VA max.

**Dimensions:** Approx. 400 (W) x 236 (H) x 499 (D) mm, 15-3/4 x 9-3/8 x 19-5/8.″

**Weight:** Approx. 17 kg (37.5 lbs)... 2 channel model, 18 kg (39.7 lbs)... 4-channel model.

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# 3655E
## ANALYZING RECORDER

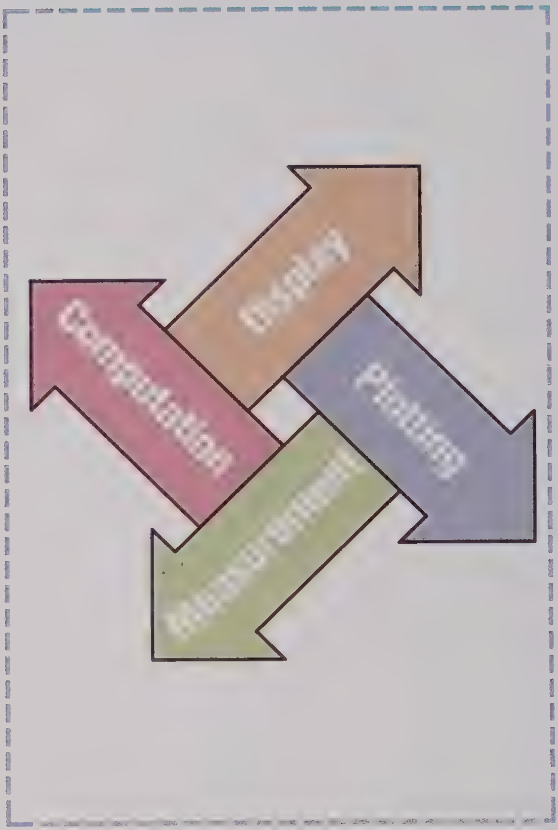
## A Powerful Tool for Waveform Analysis
with full computing capabilities and 4-color plotter.

RS-232C
GPIB

YOKOGAWA

Bulletin 3655E-E

# Simultaneous measurement, display & plotting of up to 4 channels with powerful computing capability.



The Model 3655E Analyzing Recorder is a powerful new tool with full waveform analysis capabilities. Model 3655E handles up to four channels and digitizes the signals at up to 50 kHz with 14-bit resolution. Based on all-in-one design concept, it includes an easy-to-read 7-inch CRT, four-color plotter, a variety of powerful computing functions in a single package.

## CONVENIENT FEATURES

- **14-bit resolution A-D converter**
- **5 types of TC inputs—especially powerful in analysis of fast-changing temperature signal**
- **8K or 32K words/channel of buffer memory**
- **A variety of powerful computing functions**
  - Each channel or channel-channel — +, −, ×, ÷, square root, logarithm, exponential function, absolute value, 1st and 2nd differentials and integrals, and moving averages.
  - Measured waveforms—integral, max., min., pk-pk, mean and rms.
- **2-channel FFT analysis of 2 Hz to 20 kHz (optional)**
- **X-Y recording of high-speed events**

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The data displayed on the screen is plotted in four distinctive colors by the built-in plotter. It uses an A4 paper which makes it useful for filing in standard documents.

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Installed in an edge connector slot, this is a module for analyzing one or two channels of FFT.

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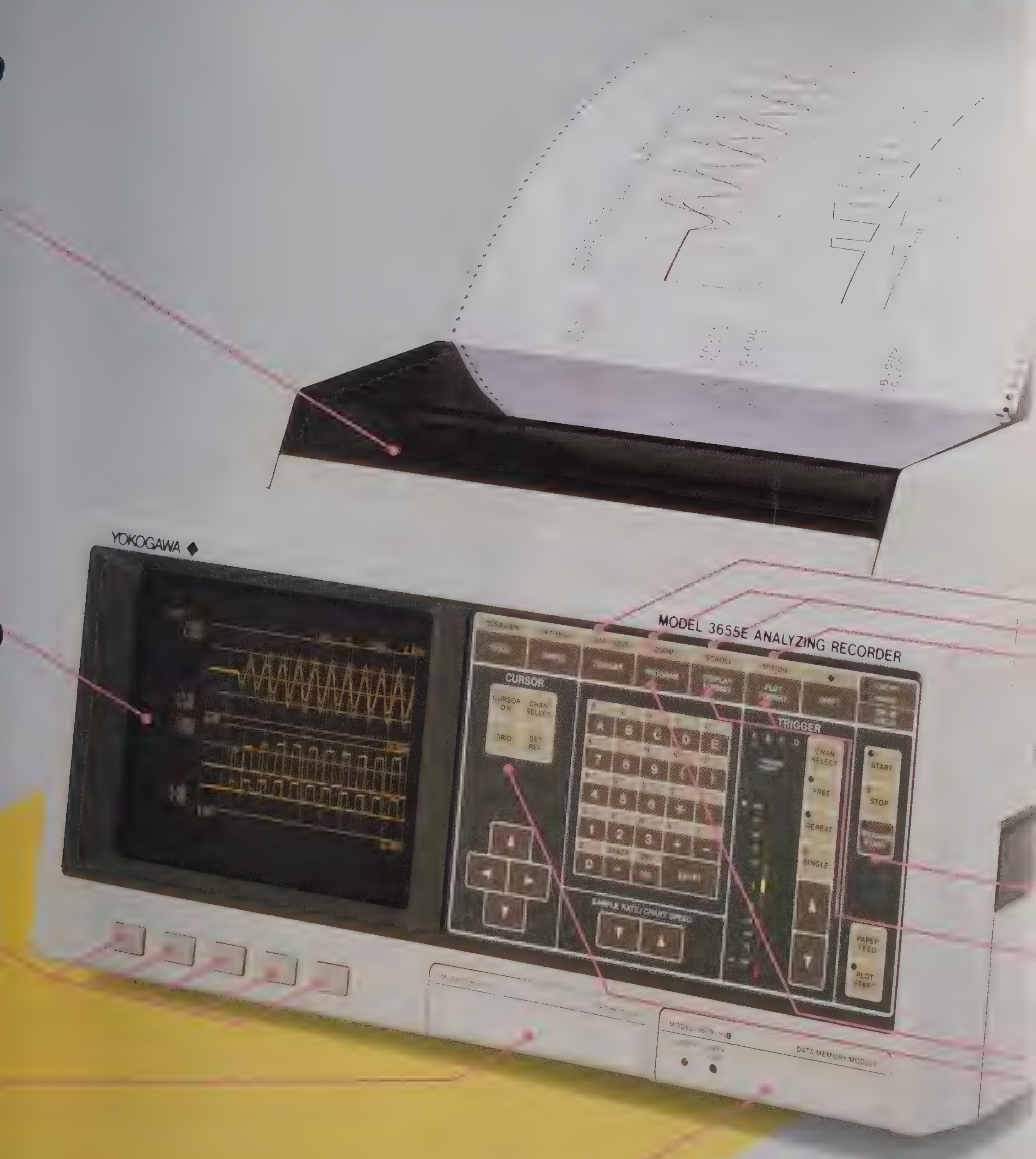

**Data memory module (optional)**
The required portion of the measured data can be stored (up to 16 files). The stored data is battery backed up.

# Specifications

## ANALOG INPUT

### VOLTAGE INPUT

**Measuring Ranges:** ±60, 200, 600 mV, 2, 6, 20, 60 V f.s.

**Max. Allowable Input Voltage:** 130 V (DC + AC pk, frequency 1 kHz max.).

**Input Impedance:** Approx. 1 MΩ.

**Frequency Band (Analog Section):** DC to 20 kHz ($^{+1}_{-3}$ dB, DC coupling), 1 Hz to 20 kHz ($^{+1}_{-3}$ dB, AC coupling), (DC to 1.5 Hz, −3 dB... real-time mode), at filter OFF.

**Input Coupling:** DC or AC (DC only in real-time mode).

**Type of Input:** Floating (unbalanced), isolated for each channel.

**Input Channels:** Up to 2 or 4.

**Accuracy:** ±0.25% of full scale on 2 V range, ±0.5% of full scale on other ranges, at filter OFF, DC, 23±3°C.

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**Filter Characteristics (Typical):** Line... −50 dB at 50 or 60 Hz, anti-aliasing... 120 dB/oct.

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**Operational Modes:** +, −, ×, ÷, SQR (square root), LOG (logarithm), EXP (exponential function), ABS (absolute value), 1st & 2nd differentials, 1st & 2nd integrals, MEAN (100-point moving average), and Option Key modes.

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**Chart Speeds:** 4 cm/min to 1 cm/h (10 steps).

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**Power Requirements:** 90 to 132 V, or 180 to 250 V AC (must be specified), 48 to 63 Hz.

**Power Consumption:** 240 VA max.

**Dimensions:** Approx. 400 (W) x 236 (H) x 499 (D) mm, 15-3/4 x 9-3/8 x 19-5/8.″

**Weight:** Approx. 17 kg (37.5 lbs)... 2 channel model, 18 kg (39.7 lbs)... 4-channel model.

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# AR3200
## ANALYZING RECORDER

## Waveform Analysis of up to 32 Channels
with memory capacity of up to 10M bytes (4M words)

RS-232-C
GPIB

YOKOGAWA

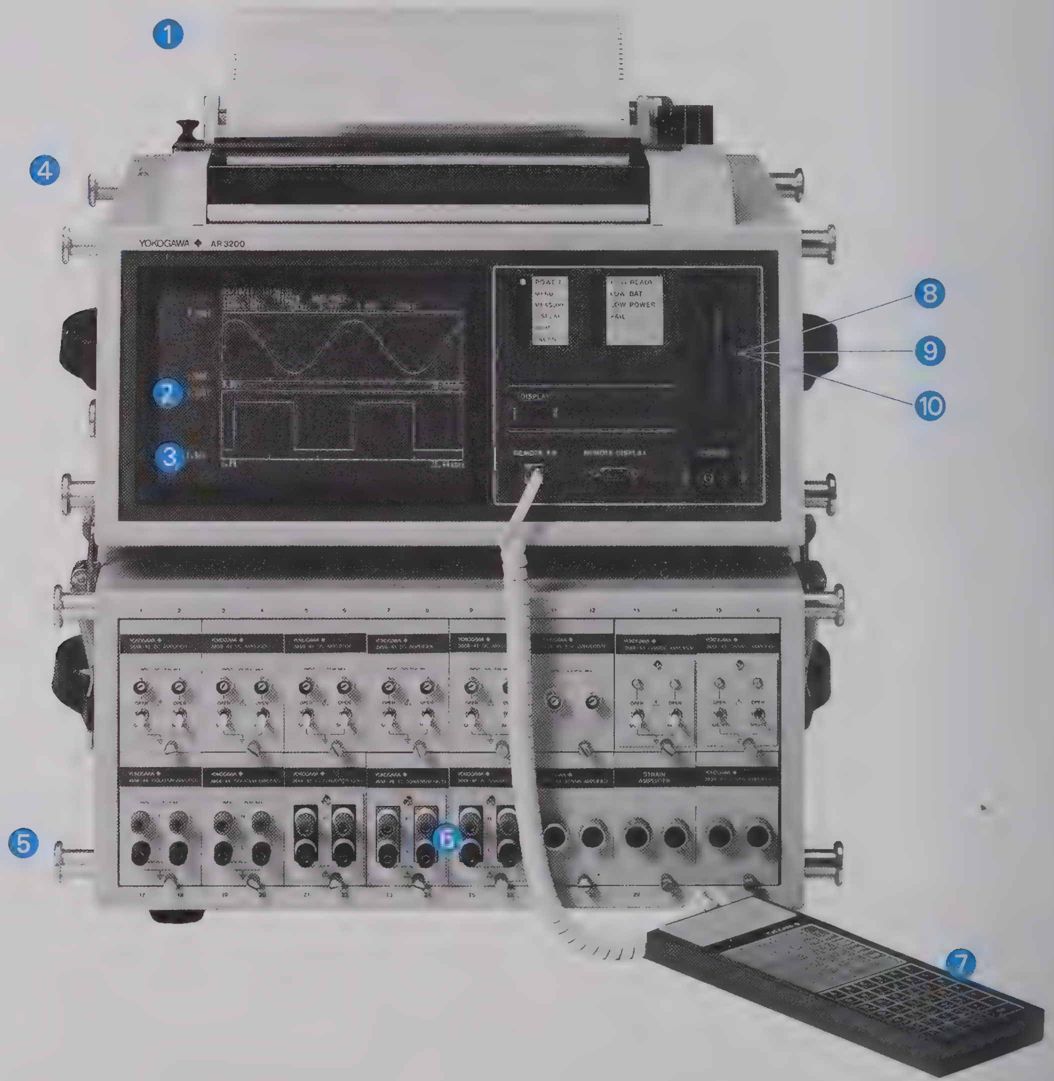
Bulletin 3657-E

# Powerful Waveform Measurement by Multi-Channel, Large Memory Capacity and Various Functions.

The AR3200 Analyzing Recorder is a multi-channel waveform measuring instrument, which measures, processes, displays and plots a variety of input signals of up to 32 channels. By incorporating large memory capacity of up to 10M bytes (approx. 4M data) and many powerful functions, AR3200 can be used for a diverse field of applications from laboratory to vehicle use.

This recorder measures data in digital form, and offers both accurate and advanced data processing for those applications which use conventional analog multi-channel waveform measuring instruments such as oscillographs and data recorders.

By selecting from seven types of input modules, AR3200 can measure a variety of variables such as voltage, current, strain, temperature, vibration, displacement, pressure and so on.



**① A built-in plotter — 4 colors, A4 size**
A built-in plotter records waveforms of measured and computed data in 4 colors (black, red, green and blue) on A4 size paper.

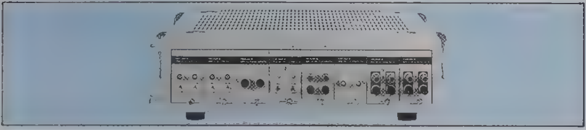
**② 9-inch EL display**
A large-size display (9 inch) is designed for vibrations proof and offers amber-colored waveform displays that are easy-to-read.

**③ 8 waveform phenomena can be displayed and recorded simultaneously**
The AR3200 can select 8 channels from a max. of 32, and simultaneously display 8 waveform phenomena.

**④ Large memory capacity — up to 10M bytes (approx. 4M data)**
The AR3200 can allow long-time measurements of multiple phenomena.

### ⑤ Multi-channels — up to 32 channels

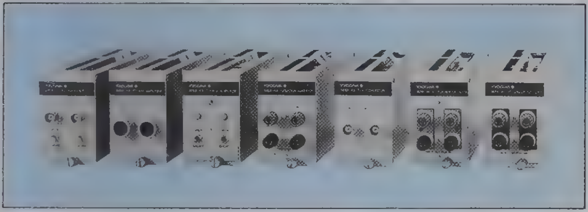
This multi-channel recorder can be used for a wide range of applications such as running test of vehicle, rotary machine testing, and data acquisition for injection molding machines. It is available in a 32- or 16-channel model.



Input Unit for 16 Channels

### ⑥ Built-in amplifiers

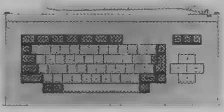
Seven types of input amplifiers are available, such as DC, strain, charge and isolation amplifiers, an F-V converter and TC converters (K/T or J/R). Each input amplifier has two input channels.



Built-in Amplifiers

### ⑦ Remote keyboard

The remote keyboard (standard) is easy-to-use in confined spaces such as on a vehicle. The full keyboard (optional) similar to that on a personal computer, which is improved operability in bench top applications such as in laboratories.



Full Key Board

### ⑧ Powerful computing functions

The following computations between channels are available: +, −, ×, ÷, square root (SQR), logarithm (LOG), exponential (EXP), absolute (ABS), first-order differentiation (DIF), second-order differentiation (DDIF), first-order integration (INTG), second-order integration (IITG), and moving average for 100 points (MEAN). The computing symbols allow the required expression to be computed and the computation results to be displayed.

WAVE PACK

- Function key computations include integral (area in any section of a measured waveform), maximum, minimum, peak-to-peak, mean, and rms value.

### ⑨ Frequency domain analysis — FFT PACK SOFT (optional)

The FFT package software allows vibration and noise frequency analysis including: a linear spectrum, power spectrum, RMS spectrum, power spectrum density, cross spectrum, transfer function and coherence function.

FFT PACK

### ⑩ Measured data and panel-set data can be stored on a 3.5-inch floppy disk

- Measured data back-up system
  The measured data and panel-set data can be stored in an internal S (static) RAM which is backed up by a battery. This allows data to be retained for approx. 1 month after power OFF.
- High resolution 14-bit A-D converter
  A built-in 14-bit A-D converter can measure data accurately (up to max. 50,000 samples/s). With this A-D converters, users can accurately measure mechanical vibration, shock, strain, etc.
- Bench or vehicle use
  Commercial power supply: 90 to 132 V AC or 180 to 250 V AC
  DC power source: 10 to 32 V DC (12 V or 24 V DC; suitable for vehicle use) ..... Optional AC adaptors are available.

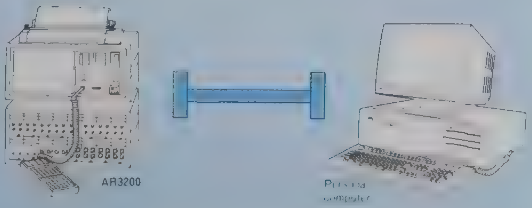
## Computer Friendly

**Communication interface with personal computers**

**GPIB RS-232-C interface (optional)**

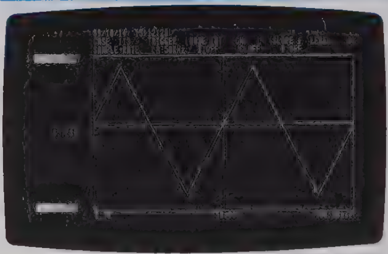
AR3200 recorders with a GPIB/RS-232-C interface can send/receive waveform data to/from an external controller.

With a personal computer connected, the system can be used for an automatic measurement system.



# Maximum Versatility in Display Formats.

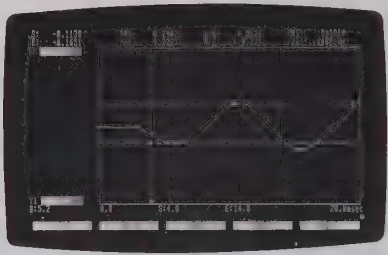
- **Displays 8 waveforms**
  Up to 8 waveforms including measured and computed signal waveforms can be displayed simultaneously. This is suitable for multi-channel data comparisons.



- **Cursor**
  The part of data specified by the cursor is shown by a digital value. This function is useful when directly reading max. or min. values of a waveform and the time.

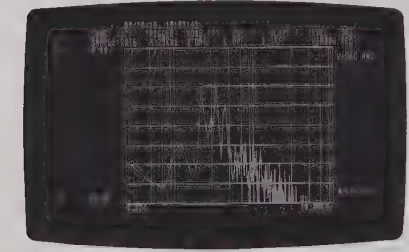
- **Zoom and scroll functions**
  A waveform identified at the cursor location is zoomed at a magnification factor depending on the size of the buffer memory setting; Vertical: up to 16, Horizontal: up to 512
  An enlarged waveform can be moved in the horizontal direction using the scroll function

- **Computing functions**
  Computing functions such as +, −, ×, ÷, square root, and logarithm are available.
  The waveforms shown above are power waveforms, resulting from combining the current and voltage

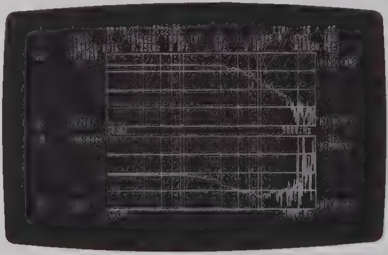


- **Direct digital readout of measured waveforms - integral, max., min., pk-pk, mean, rms**
  For the displayed waveforms, any six of the above digital data can be displayed and printed out by using this function.

- **X-Y mode display**
  Any channel of the measured or computed data can be selected on the X-axis with the other one to max. seven channels on the Y-axis to provide X-Y display



- **FFT analysis**
  FFT package software (optional) allows FFT analysis such as: Linear spectrum, power spectrum, power spectrum density, RMS spectrum, cross spectrum, transfer function, and coherence function.



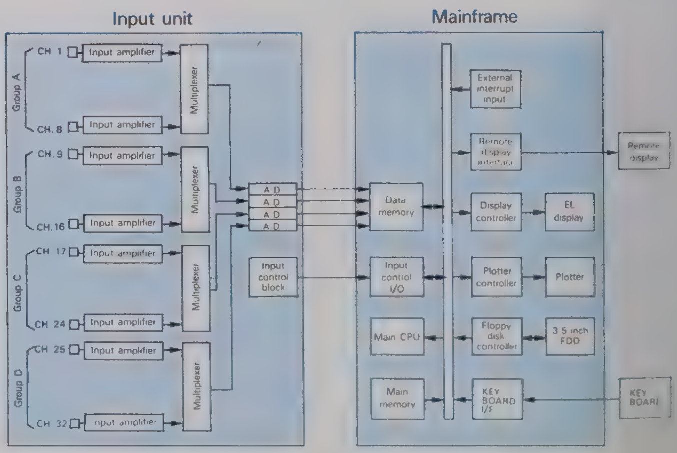
- **Transfer function**
  Transfer function computations between two channels are available. Amplitude and phase characteristics can be viewed simultaneously. This function is useful in analyzing the resonant frequency of a structure using an impulse hammer or the phase and amplitude characteristics of a filter.

- **Array display**
  An array display shows the change in the frequency with time, which is ideal for a rotary machine troubleshooting to measure the amplitude spectrum of a shaft vibration or to repair a defective point.

## Block Diagram of AR3200

The AR3200 consists of the mainframe and the input unit. The input unit can accommodate input modules of up to 32 or 16 channels. Inputs are selected in a group of 8 channels, and sent to A-D converter.

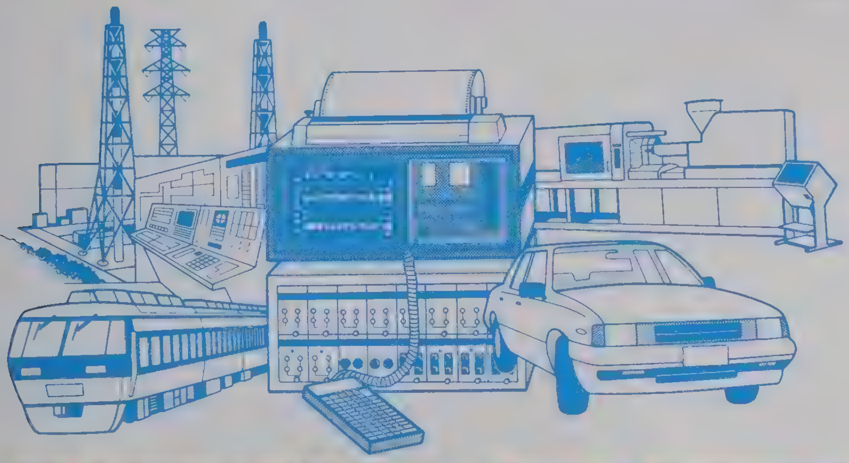
A-D converted output data are stored in the data memory of mainframe. The main CPU in the mainframe controls the plotter, EL display, floppy disk, keyboard, remote display, and more.



32-channel model includes group A, B, C and D.

16-channel model includes group A and B.

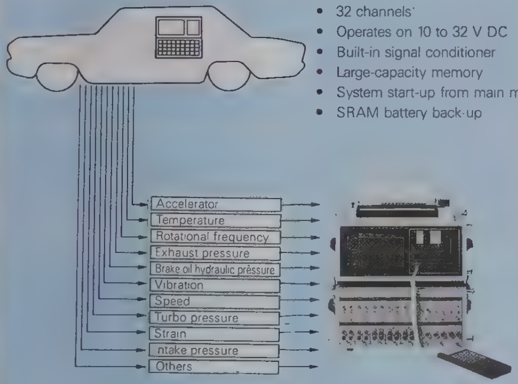
# Applications Unlimited through Comprehensive Analysis Functions.



## Data analysis of vehicle-operation tests

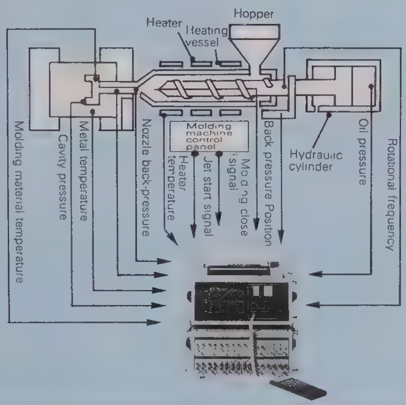
Recorders can be installed in a vehicle and measured data can be stored.

- 32 channels
- Operates on 10 to 32 V DC
- Built-in signal conditioner
- Large-capacity memory
- System start-up from main memory
- SRAM battery back-up

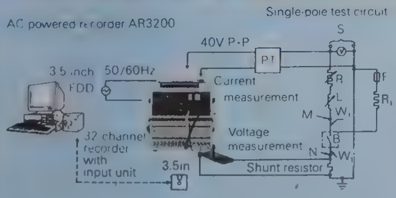


## Applications for injection molding

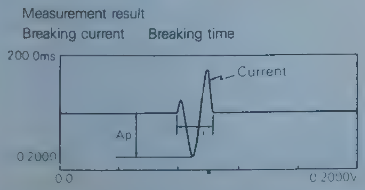
The AR3200 is ideal for testing injection molding machines. The AR3200, in combination with an injection-molding machine, can measure the temperature, position, pressure, and the speed essential in manufacturing plastc products.



## Breaker testing



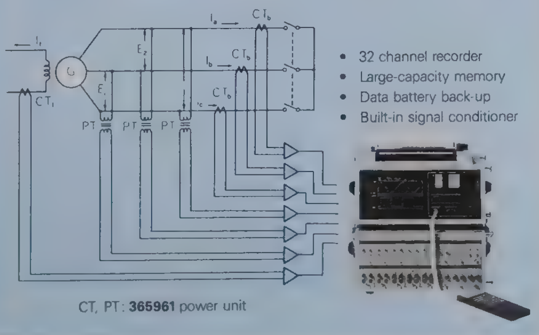
Apply power to the testcircuit, and short-circuit it between M and N; then, measure the current and voltage waveforms using the AR3200.



## Generator short-circuit testing

Measure the three-phase current and voltage waveforms developed when the generator load is short-circuited. The AR3200 recoder can easily measure the short-circuit current amplitude using cursor functions, enabling the generator short circuit to be tested effectively.

- 32 channel recorder
- Large-capacity memory
- Data battery back-up
- Built-in signal conditioner



CT, PT: **365961** power unit

# SPECIFICATIONS

## Specifications(Mainframe)

### INPUT

**Number of Input Channels**

Up to 16 (up to 8 input modules) .....**36571□**, **36573□**
Up to 32 (up to 16 input modules).....**36572□**, **36574□**

### A-D CONVERSION

**A-D Converters:** Two groups (A, B)...16-channel model, four groups (A, B, C, D) ... 32-channel model.

**Resolution:** 14 bits

**Conversion speed:** 20$\mu$s.

### MEMORY

**Maximum Memory Capacity Total (for All Channels):** 0.5M words **(3657□1)**, 1M words **(3657□2)**, 2M words **(3657□3)**, 3M words **(3657□4)**, 4M words **(3657□5)**.

### GENERAL SPECIFICATIONS

**Display Tube:** 120×192mm (4-3/4×7-1/2″) electroluminescence (EL), amber 640×200 dots resolution.

**Plotter:** Four-color digital plotter using ball-point pens (black, red, green, blue ... water ink).

**FDD:** 3.5″ high-density floppy disk drive.

**Storage of System Program and Measured Data:** Ni-Cd battery backup.

**Storage of Measuring Conditions:** Up to eight conditions (Ni-Cd battery backup).

**Clock Accuracy:** Approx. ±50 ppm (Ni-Cd battery backup).

**Ni-Cd Battery Life:** Approx. one month at 0 to 40℃ (After continuous charging for 20 hours or trickle charging for 40 hours)

**Storage Temperature Range:** −30 to +60℃ (−22 to +140°F).

**Operating Temperature Range:** 0 to 50℃, 32 to 122°F(5 to 40℃, 41 to 104 °F under FDD and plotter operation).

**Humidity Range:** 10 to 90%, relative humidity (20 to 80% at FDD operation, or 40 to 80% at plotter operation).

**Power Requirements:** 10 to 32V DC, 90 to 132V AC, or 180 to 250V AC.

**Power Consumption:** 200VA max. (with all optional features).

**Dimensions:** Mainframe ... approx. 438(W)×400(D)×259(H)(17-1/4×15-3/4×10-1/2″), input unit ... approx. 438(W)×400(D)×200 or 117(H)mm (17-1/4×15-3/4×7-7/8 or 4-5/8″).

**Weight:** Mainframe ... approx. 18kg max. (39.7 lbs), input unit ... approx. 12kg (26.5 lbs), or 8.5kg (18.7 lbs), not including input modules.

**Accessories supplied at no extra cost:** Roll chart ... 1 roll, ball-point pens ... 4 pcs. (black, red, green, blue), chart roller ... 1 pc., chart guide ... 1 set, fuse ... 2 pcs., system disk ... 2 disks, blank seal ... 10 sheets, instruction manual ... 1 copy, power cord ... 1 set (for AC model), DC source connector ... 1 pc. (for DC model).

## Optional Features

● /REM

**1) REMOTE DISPLAY**

**Display Functions:** Digital display of measured data in designated channels, and bar graph display of signal level in designated channels.

**2) EXTERNAL INTERRUPT**

**Number of Input Channels:** Up to 8.

**Interrupt Triggering:** Fall.

**Input Signal:** TTL-level or contact signal

**Remote Control functions:** Following functions can be controlled by external interrupt signal actuated when the signal changes from H to L level.

① Measurement (START), Measurement (STOP), Data sampling (SAMPLING START)
② Increment of remote display channel No. (INCREMENT CH No.)
③ Decrement of remote display channel No. (DECREMENT CH No.)
④ Strain gauge bridge balancing (BALANCE)

● /EXT

/EXT also includes the function of remote display (/REM).

## Specifications (Application Packages)

### ■ WAVE-PACK (STANDARD)

### Measuring Modes

**Normal Mode:** (1) Measures in designated number of times, and the measured data are stored (1 to 3,000 times max. depending on the memory capacity), PREDISPLAY OFF.
(2) Instantaneous value in a specified channel is displayed on Remote Display (optional). Measured data are stored by depressing F6 (SAMPLING START) key, PREDISPLAY ON.

**Repeat Mode:** Measurements are repeated, and the last measured data is stored by depressing the F6 key.

**Monitor Mode:** Data for all channels are repeatedly displayed in digital.

### Memory

**Memory Setting:** Setting by measuring time, or setting by memory capacity ... 512, 1K, 2K, 4K, 8K, 16K, 32K, 64K, 128K, 256K, 512K, or 1M words/channel (limited by max. memory capacity).

- When a plotter is used:
  Use the same memory capacity as in the data quantity that is output to the plotter.
- When a program is executed:
  When the measured data is computed, a memory capacity as much as two times larger than the measured data quantity is needed

**Writing Speed Designation:** 50, 25, 10, 5, 2.5, 1kHz, 500, 250, 100, 50, 25, 10, 5, 2.5 or 1Hz (for each group).

| | DC AMPLIFIER (365941) | ISOLATION AMPLIFIER (365944) | STRAIN AMPLIFIER (365942) |
|---|---|---|---|
| **Number of Input Channels** | 2 | 2 | 2 |
| **Input Circuit** | Unbalanced (0Ω; SHORT or 200Ω; OPEN selectable for impedance between input L and case) | Floating | |
| **Measuring Ranges** | ±60, 200, 600mV, 2, 6, 20V full scale. | | ±200, 600, 2,000, 6,000, or 20,000 x 10⁻⁶ strains |
| **Maximum Input Voltage** | 50V (DC+AC peak) | | ±10V (DC+AC peak), normal and common modes. |
| **Input Impedance** | 1MΩ (more than 10kΩ for overrange input) | | More than 10MΩ |
| **Frequency bandwidth** | DC to 20kHz (−3dB at filter OFF) | DC to 5kHz (−3dB at filter OFF) | DC to 20kHz (−3dB at filter OFF) |
| **Low-Pass Filter** | 10, 30, 300Hz or OFF (18dB/octave) | 10, 30, 300Hz or OFF (18dB/octave) | 10, 30, 300Hz or OFF (18dB/octave) |
| **Accuracy** | ±(0.2% of full scale + 50$\mu$V) with filter set at 300Hz and DC input, at 23±3℃ | ±(0.3% of full scale + 50$\mu$V) at filter 300Hz and DC input, 23±3℃ | ±(0.5% of full scale + 2$\mu$V) at filter 300Hz and DC input, 23±3℃ (not including influence of input cable) |
| **Temperature Coefficient** | ±(0.02% of full scale + 20$\mu$V)/℃ after automatic calibration | ±(0.03% of full scale + 20$\mu$V)/℃ after automatic calibration | Zero drift...±1$\mu$V/℃, sensitivity change... ±(0 025% of full scale)/℃ after automatic calibration |
| **Input Connector** | BNC | Binding post | Conforms to NDIS standard |
| **Weight** | Approx. 420g (0.93 lbs) | Approx. 600g (1.32 lbs) | Approx. 450g (0.99 lbs) |
| | **Type:** Direct-coupled DC type | | **Circuit:** DC bridge (auto-balancing), differential direct-coupled DC amplifier. |
| | **Linearity:** Less than ±0.01% of full scale | **Linearity:** Less than ±0.05% of full scale | **Gauge Resistance:** 120 to 1,000Ω |
| | **Maximum Common Mode Voltage:** 1 4V (DC+AC peak) at differential input impedance 200Ω (OPEN) between input L and case | **Maximum Common Mode Voltage:** 140V (DC + AC peak) | **Gauge Factor:** 200 |
| | | **Dielectric Voltage:** 1,000V AC for one minute between input and case | **Bridge Voltage:** 2V DC (remote sensing) |
| | | | **Applicable Bridge Head:** **319300** (optional accessory) |
| | | | **Linearity:** Less than 0.01% of full scale (at 20,000x 10⁻⁶ strain range |
| | | | **Automatic Balancing Range:** Less than ±4,000x 10⁻⁶ strains (at gauge resistance of 120Ω) |

**Maximum Writing Speed (For Each A-D Conversion Group):** 50kHz (for 1 channel), 25kHz (for 2 channels), 10kHz (for 4 cahnnels), 5kHz (for 8 channels).
**Pre-Trigger Setting:** 1 word to 1M words.
**Writing Method:** Channel selecting measurement in each group.
**Time Difference of Measuring Time:** Within same group ... max. 140$\mu$s, in each group ... one cycle at latest group + 140$\mu$s.

## Triggering

**Trigger modes:** ON, OFF.
**Trigger Source:** Internal (trigger channel freely selectable), external (TTL-level), or MANUAL.
**Trigger Slope:** Rise (↗) or fall (↘).
**Trigger Level:** −100% to +100% (internal, 2% steps), TTL-level (external).
**Averaging:** Linear sum or external averaging (number of averaging... 2, 4, 8, 16, 32, 64, 128, 256, times preselectable).

## Computing

**Operational Modes:** +, −, ×, ÷, SQR (square root), LOG (logarithm), EXP(exponential function), ABS(absolute value), 1st & 2nd differentials, 1st & 2nd integrals, MEAN (100-point moving average), and function key modes.
Data computation between channels or functional computation for each channel (by setting measured data, function symbols and constant symbols within 60 characters).
**Function key computations:** Y-T display ... max.,min., peak to peak, average, rms value, area (waveform enclosed by 2-channel), X-Y display ... (enclosed by waveform and cursors)

## Display

**Display Formats:** Single ... 1 to 8 waveforms on a single screen (Y-T), dual ... 1 to 4 waveforms each on two screens (Y-T), quadruple ...1 waveform each on four screens (Y-T),X-Y ... X-Y display of up to 7 channels.
**Cursor:** Y-T or X-Y data of any waveform identified by the cursor can be displayed in digital.
**Reference Cursors:** Deviation between two points designated by the cursors can be displayed in digital.
**Scaling:** Scaling is possible for both vertical and time axes.
**Zoom and scroll functions:** A waveform can be zoomed in on up to 16 times its size in the direction of the vertical axis and up to 512 times in the direction of the horizontal axis. The scroll function allows waveforms to be moved along the time axis.

## Plotting

**Writing System:** X-Y plotter.
**Plotting Size:** A4, A5 (copy mode), or continuous (analog or digital mode).
**Plotting modes:** (1) Hard copy of display ... direction setting; 0° or 90°, magnification factor; 1 or 2
(2) Analog plotting of data in a designated range.
(3) Digital plotting of data in a designated range (up to 4 channels).
(4) Program list printout (all or designated programs).

**Title Plotting:** Waveform title of up to 40 characters can be entered and plotted by using programming keys.
**Duplex Plotting:** One or more measured data (waveforms) can be superimposed over an initial plot.
**Graph (Channel) Identification Numbering:** Graph (channel) identification numbering is marked along each waveform.

## Storage Medium

**Floppy:** 3.5″.
**Data Saving:** Saving by designating the case. (in case of a data overflow, the data that is completely saved is still effective)
**Saving of Panel Setting Conditions:** Conditions set from the panel can be stored.
**GPIB/RS-232-C (Optional)**
**GPIB Interface:** Meets the IEEE Standard 488-1978.
**RS-232-C Interface:** Meets the EIA RS-232-C.
**Interface Functions:** Data output, programming and program execution.

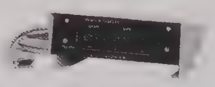
## ■ FFT-PACK (OPTIONAL)

**Analyzing:** Linear spectrum, power spectrum density, rms spectrum, cross spectrum, transfer function, and coherence function.
**Number of Channels:** Up to 8.
**Sampling Frequency:** 50, 25, 10, 5 2.5 1kHz, 500, 250, 100, 50, 25, 10, 5, 2.5 or 1Hz.
**Frequency Range:** fs/2.56(fs: sampling frequency).
**Data Sampling:** 512, 1,024, 2,048 points
**Frequency Resolution:** 1/200 (for 512 words), 1/400 (for 1,024 words), 1/800 (for 2,048 words) of frequency range.
**Weighting:** Hanning or rectangular window.
**Averaging Modes:** Linear sum (stable), or exponential averaging for time and frequency domain (number of averages ... 2, 4, 8, 16, 32, 64, 128 or 256 times, preselectable).
**Triggering:** Refer to Wave-Pack.
**Display Format:** Single, dual
Nyquist ... one on single screen
Array ... 2 or 3 dimensions
Number of division: 2 to 128.
**Plot:** Refer to Wave-Pack (except for "Analog, Digital" plotting).
**Measuring mode, memory and storage mode:** Refer to Wave-Pack.

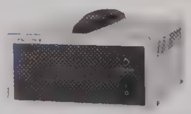
| CHARGE AMPLIFIER (365943) | F-V CONVERTER (365945A) | TC CONVERTER (365946) | TC CONVERTER (365947) |
|---|---|---|---|
| 2 | 2 | 2 | 2 |
| Unbalanced (0Ω; SHORT or 200Ω; OPEN selectable for impedance between input L and case) | Unbalanced, Direct-coupled | Floating (between channels) | |
| ±2, 20, 200, 2,000G (1 to 10 pc/G),<br>±0.2, 2, 20, 200G (10 to 100 pC/G) | 60 to 1,000 rpm<br>60 to 10,000 rpm | Type K...0 to 1,200℃,<br>Type T...−50 to +200℃ | Type J...0 to 800℃,<br>Type R...0 to 1,600℃ |
| | 50V (DC + AC peak) | 30V (DC + AC peak) | |
| | 1MΩ | More than 10MΩ (more than 10MΩ for over-range input) | |
| 1Hz to 20kHz (−3dB at filter OFF) | | DC to 10Hz (−3dB) | |
| 10, 30, 300Hz or OFF (18dB/octave) | | | |
| ±2% of full scale at filter 300Hz and 100Hz input, 23±3℃ | ±0.3% of full scale at 23±3℃ | ±(0.3% of full scale + 3℃) at 23±3℃ | Type J...±(0.3% of full scale+3℃), Type R (0 to 400℃) ...±(0.3% of full scale+8℃), Type R (400 to 1,600℃)...±(0.3% of full scale+6℃) |
| ±(0.2% of full scale)/℃ after automatic calibration | ±(0.01% of full scale)/℃ | ±(0.03% of full scale)/℃ | |
| Coaxial type | BNC | Binding post | |
| Approx. 480g (1.1 lbs) | Approx. 420g (0.93 lbs) | Approx. 630g (1.39 lbs) | Approx. 630g (1.39 lbs) |
| **Measuring Pick-up Sensitivity:** 1 to 100 pc/G, selectable | **Frequency Dividing Ratio:** 1 to 1,000 (resolution 1) selectable | **TC Type:** K and T (ANSI, JIS) | **TC Type:** J and R (ANSI, JIS) |
| **Meximum Input Charge:** 20,000 pC | **Trigger Level:** Within ±5V, selectable (resolution 0 1V) (Amplitude changes of +100mV at the center of the input trigger level setpoint are required.) | **Accuracy of Reference Junction Compensation:** ±0.8℃ at 0 to 50℃ | **Accuracy of Reference Junction Compensation:** Type J...±0.8℃, Type R ...±1.6℃, at 0 to 50℃ |
| **Maximum Common Mode Voltage:** 1.4V (DC+AC peak) at 200Ω (OPEN)between input L and case | **Response:** 2 pulses +20mS or 50mS second (whichever is longer). For the frequency-division N, 2N pulses +20mS or 50mS (whichever is longer) | **Common Mode Rejection:** More than 90dB at 50 or 60Hz, unbalanced resistance 1kΩ | |
| | | **Maximum Common Mode Voltage:** 140V (DC + AC peak) | |
| | | **Dielectric Voltage:** 1,000V AC for one minute between input and case | |
| | | | |
| | | | |

## Optional Features & Accessories

- Remote display (/REM)



- AC adapter (365960)



- Bridge head (319300)

- DC power cord (365997)

### AC ADAPTER (365960)

**Input:** 90 to 132/180 to 250V AC (automatic switching), 47 to 63Hz.
**Output:** 12V DC.
**Output Current:** 20A.
**Cord Length to Mainframe:** 1m (standard accessory).

### DC POWER CORD (365997)

**Termination:** Connector (to mainframe) and alligator clips (power supply).
**Cord Length:** 2m (three wires).

### BRIDGE HEAD (319300)

**Cord Length:** 5m.
**Connector:** Conforms to NDIS standard.

# AVAILABLE MODELS

## Mainframe

| Model | | Suffix Codes | Option Codes | Description | | |
|---|---|---|---|---|---|---|
| **3657** | | | | AR3200 Analyzing Recorder | | |
| | | | | Memory size | Power requirement | No. of channels |
| Memory Size, Power Requirements & No. of Channels | **11** | -B | | 2M bytes | DC | Up to 16 |
| | **12** | | | 4M bytes | | |
| | **13** | | | 6M bytes | | |
| | **14** | | | 8M bytes | | |
| | **15** | | | 10M bytes | | |
| | **21** | -B | | 2M bytes | DC | Up to 32 |
| | **22** | | | 4M bytes | | |
| | **23** | | | 6M bytes | | |
| | **24** | | | 8M bytes | | |
| | **25** | | | 10M bytes | | |
| | **31** | -1 or -5 | | 2M bytes | AC | Up to 16 |
| | **32** | | | 4M bytes | | |
| | **33** | | | 6M bytes | | |
| | **34** | | | 8M bytes | | |
| | **35** | | | 10M bytes | | |
| | **41** | -1 or -5 | | 2M bytes | AC | Up to 32 |
| | **42** | | | 4M bytes | | |
| | **43** | | | 6M bytes | | |
| | **44** | | | 8M bytes | | |
| | **45** | | | 10M bytes | | |
| Power Requirements | | -B | | 10 to 32V DC | | |
| | | -1 | | 90 to 132V AC | | |
| | | -5 | | 180 to 250V AC | | |
| Optional Features | | | /**REM** | Remote display (including/**EXT**) | | |
| | | | /**EXT** | External interrupt | | |
| | | | /**DSP** | Digital signal processing | | |
| | | | /**GP-IB** | GPIB interface | | |
| | | | /**RS232C** | RS-232-C interface | | |

Notes: 1. Both /**GPIB** and/**RS232C** interfaces,are not compatible with a single unit
2./**DSP** must be specified when using FFT Pack.

### Input Modules (Optional)

| Model | Name | Description |
|---|---|---|
| **365941** | DC amplifier | 2 channels (±60mV to 20V) |
| **365942** | Strain amplifier | 2 channels (±200 to 20,000 x μstrains) |
| **365943** | Charge amplifier | 2 channels (0.2 to 200G) |
| **365944** | Isolation amplifier | 2 channels (±60mV to 20V) |
| **365945A** | F-V converter | 2 channels (60 to 10,000 rpm) |
| **365946** | TC converter | 2 channels (JIS, ANSI...K, T) |
| **365947** | TC converter | 2 channels (JIS, ANSI...J, R) |

### Software Package (Optional)

| Model | Name | Description |
|---|---|---|
| **365986** | FFT pack | Use with /**DSP** |

### Optional Accessories

| Code | Name | Description |
|---|---|---|
| **365960** | AC adapter | AC power supply (90 to 132/180 to 250 V AC, switch selectable) for DC model |
| **365988** | Full Keyboard | Full Keyboard for AR3200 |
| **365996** | Blank panel | For panel space of a single input module |
| **365997** | DC power cord | For DC operation |
| **319300** | Bridge head | For **365942** |
| **365961*** | Power unit | 2 channels each (V, A) |
| **366921*** | Conversion adapter | BNC-banana |
| **366923*** | Plug adapter | T-shaped |
| **366924*** | BNC cable | BNC-BNC (1m) |
| **366925*** | BNC cable | BNC-BNC (2m) |
| **366926*** | Clip lead | BNC clip (1m) |
| **B9409LA*** | Measurement lead | Banana-clip (1m) |

Note: *Also usable for 3655E and 3656

### Spares

| Name | Parts No. | Description | Order Q'ty |
|---|---|---|---|
| Roll chart | **B9708AR** | 20m (1 roll/unit) | 6 units |
| Ball-point pen (water ink) | **B9708QA** | Black (4 pcs./unit) | 1 unit |
| | **B9708QB** | Red (4 pcs./unit) | 1 unit |
| | **B9708QC** | Green (4 pcs./unit) | 1 unit |
| | **B9708QD** | Blue (4 pcs./unit) | 1 unit |

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# AR3200

## ANALYZING RECORDER

### Waveform Analysis of up to 32 Channels

with memory capacity of up to 10M bytes (4M words)

RS-232-C
GPIB

YOKOGAWA

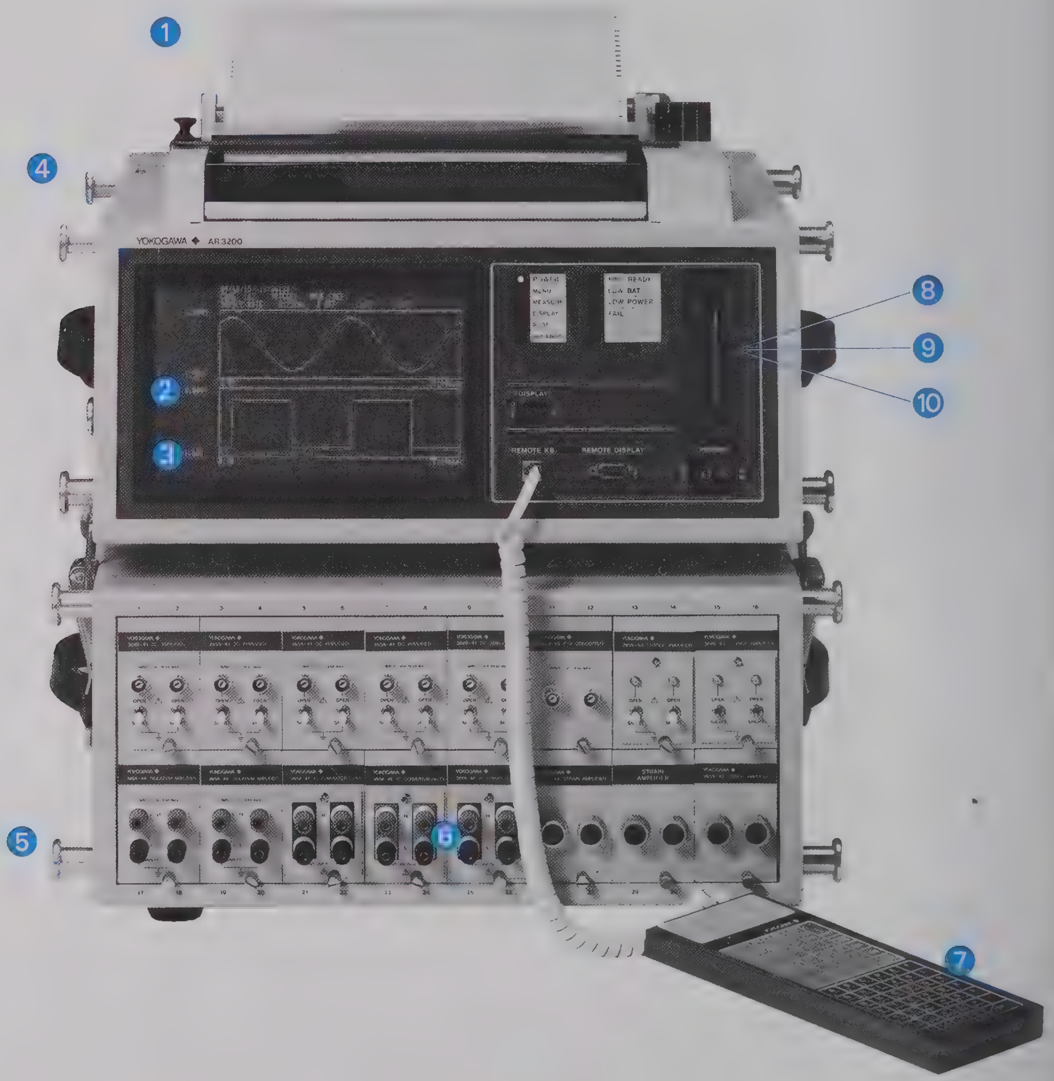
Bulletin 3657-E

# Powerful Waveform Measurement by Multi-Channel, Large Memory Capacity and Various Functions.

The AR3200 Analyzing Recorder is a multi-channel waveform measuring instrument, which measures, processes, displays and plots a variety of input signals of up to 32 channels. By incorporating large memory capacity of up to 10M bytes (approx. 4M data) and many powerful functions, AR3200 can be used for a diverse field of applications from laboratory to vehicle use.

This recorder measures data in digital form, and offers both accurate and advanced data processing for those applications which use conventional analog multi-channel waveform measuring instruments such as oscillographs and data recorders.

By selecting from seven types of input modules, AR3200 can measure a variety of variables such as voltage, current, strain, temperature, vibration, displacement, pressure and so on.



**❶ A built-in plotter — 4 colors, A4 size**

A built-in plotter records waveforms of measured and computed data in 4 colors (black, red, green and blue) on A4 size paper.

**❷ 9-inch EL display**

A large-size display (9 inch) is designed for vibrations proof and offers amber-colored waveform displays that are easy-to-read.

**❸ 8 waveform phenomena can be displayed and recorded simultaneously**

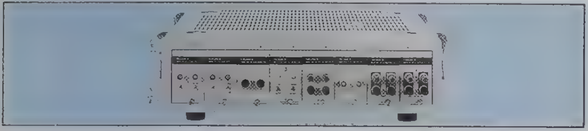
The AR3200 can select 8 channels from a max. of 32, and simultaneously display 8 waveform phenomena.

**❹ Large memory capacity — up to 10M bytes (approx. 4M data)**

The AR3200 can allow long-time measurements of multiple phenomena.

### ⑤ Multi-channels — up to 32 channels

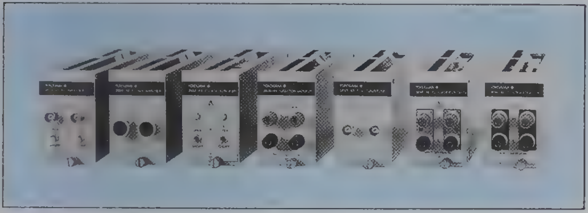
This multi-channel recorder can be used for a wide range of applications such as running test of vehicle, rotary machine testing, and data acquisition for injection molding machines. It is available in a 32- or 16-channel model.



Input Unit for 16 Channels

### ⑥ Built-in amplifiers

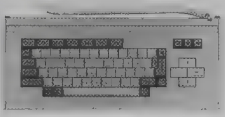
Seven types of input amplifiers are available, such as DC, strain, charge and isolation amplifiers, an F-V converter and TC converters (K/T or J/R). Each input amplifier has two input channels.



Built-in Amplifiers

### ⑦ Remote keyboard

The remote keyboard (standard) is easy-to-use in confined spaces such as on a vehicle. The full keyboard (optional) similar to that on a personal computer, which is improved operability in bench top applications such as in laboratories.



Full Key Board

### ⑧ Powerful computing functions

The following computations between channels are available: +, −, ×, ÷, square root (SQR), logarithm (LOG), exponential (EXP), absolute (ABS), first-order differentiation (DIF), second-order differentiation (DDIF), first-order integration (INTG), second-order integration (IITG), and moving average for 100 points (MEAN). The computing symbols allow the required expression to be computed and the computation results to be displayed.

WAVE PACK

- Function key computations include integral (area in any section of a measured waveform), maximum, minimum, peak-to-peak, mean, and rms value.

### ⑨ Frequency domain analysis — FFT PACK SOFT (optional)

The FFT package software allows vibration and noise frequency analysis including: a linear spectrum, power spectrum, RMS spectrum, power spectrum density, cross spectrum, transfer function and coherence function.

FFT PACK

### ⑩ Measured data and panel-set data can be stored on a 3.5-inch floppy disk

- Measured data back-up system
  The measured data and panel-set data can be stored in an internal S (static) RAM which is backed up by a battery. This allows data to be retained for approx. 1 month after power OFF.
- High resolution 14-bit A-D converter
  A built-in 14-bit A-D converter can measure data accurately (up to max. 50,000 samples/s). With this A-D converters, users can accurately measure mechanical vibration, shock, strain, etc.
- Bench or vehicle use
  Commercial power supply: 90 to 132 V AC or 180 to 250 V AC
  DC power source: 10 to 32 V DC (12 V or 24 V DC; suitable for vehicle use) ..... Optional AC adaptors are available.

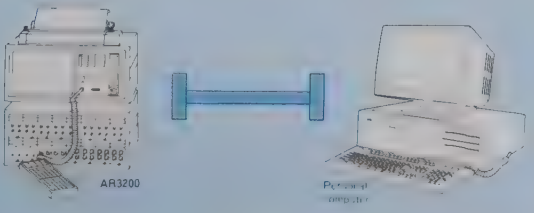
## Computer Friendly

**Communication interface with personal computers**

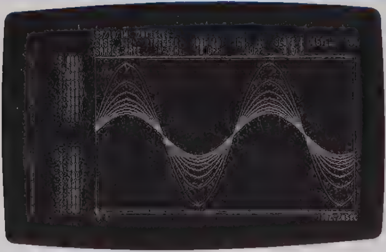
**GPIB/RS-232-C interface (optional)**

AR3200 recorders with a GPIB/RS 232-C interface can send/receive waveform data to/from an external controller.

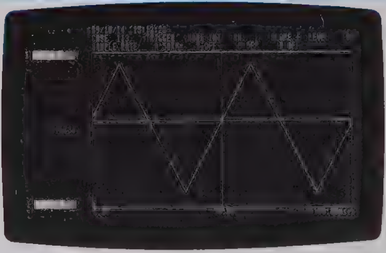
With a personal computer connected, the system can be used for an automatic measurement system.



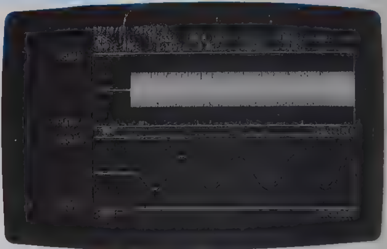
# Maximum Versatility in Display Formats.



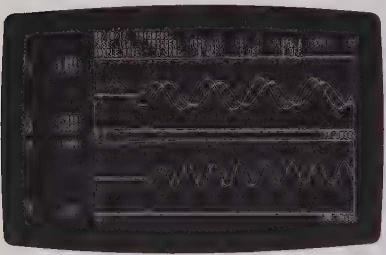
- **Displays 8 waveforms**
  Up to 8 waveforms including measured and computed signal waveforms can be displayed simultaneously. This is suitable for multi-channel data comparisons.



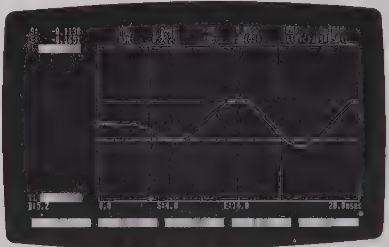
- **Cursor**
  The part of data specified by the cursor is shown by a digital value. This function is useful when directly reading max. or min. values of a waveform and the time.



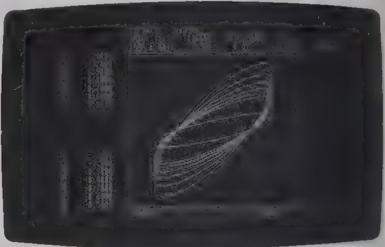
- **Zoom and scroll functions**
  A waveform identified at the cursor location is zoomed at a magnification factor depending on the size of the buffer memory setting; Vertical: up to 16, Horizontal: up to 512
  An enlarged waveform can be moved in the horizontal direction using the scroll function



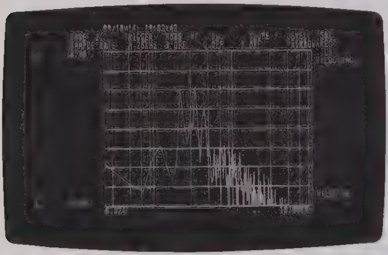
- **Computing functions**
  Computing functions such as +, −, ×, ÷, square root, and logarithm are available.
  The waveforms shown above are power waveforms, resulting from combining the current and voltage.



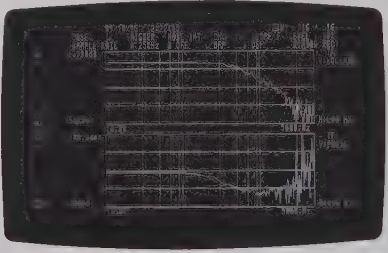
- **Direct digital readout of measured waveforms — integral, max., min., pk-pk, mean, rms**
  For the displayed waveforms, any six of the above digital data can be displayed and printed out by using this function.



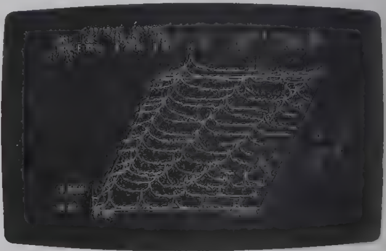
- **X Y mode display**
  Any channel of the measured or computed data can be selected on the X-axis with the other one to max. seven channels on the Y-axis to provide X-Y display



- **FFT analysis**
  FFT package software (optional) allows FFT analysis such as: Linear spectrum, power spectrum, power spectrum density, RMS spectrum, cross spectrum, transfer function, and coherence function.



- **Transfer function**
  Transfer function computations between two channels are available. Amplitude and phase characteristics can be viewed simultaneously. This function is useful in analyzing the resonant frequency of a structure using an impulse hammer or the phase and amplitude characteristics of a filter.

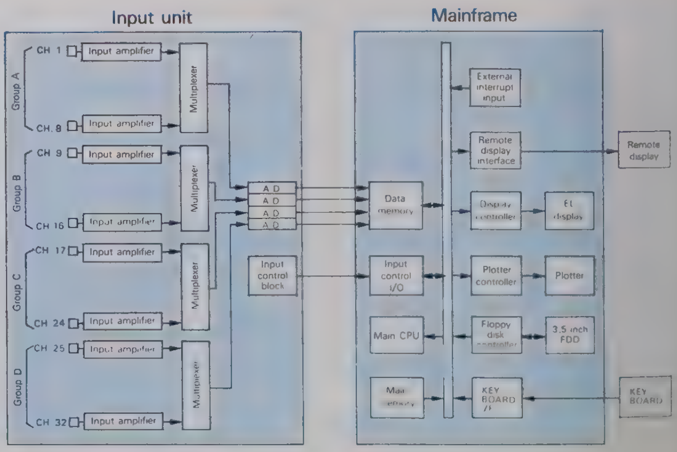


- **Array display**
  An array display shows the change in the frequency with time, which is ideal for a rotary machine troubleshooting to measure the amplitude spectrum of a shaft vibration or to repair a defective point.

## Block Diagram of AR3200

The AR3200 consists of the mainframe and the input unit. The input unit can accommodate input modules of up to 32 or 16 channels. Inputs are selected in a group of 8 channels, and sent to A-D converter.

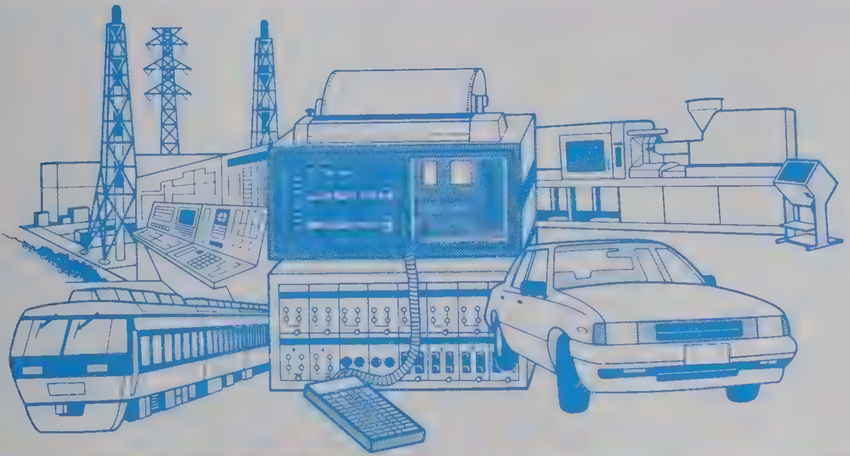
A-D converted output data are stored in the data memory of mainframe. The main CPU in the mainframe controls the plotter, EL display, floppy disk, keyboard, remote display, and more.



32-channel model includes group A, B, C and D.

16-channel model includes group A and B.

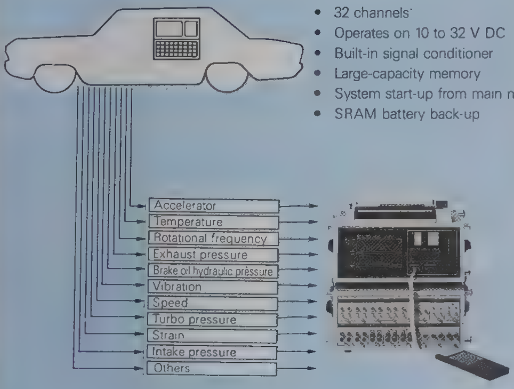
# Applications Unlimited through Comprehensive Analysis Functions.



## Data analysis of vehicle-operation tests

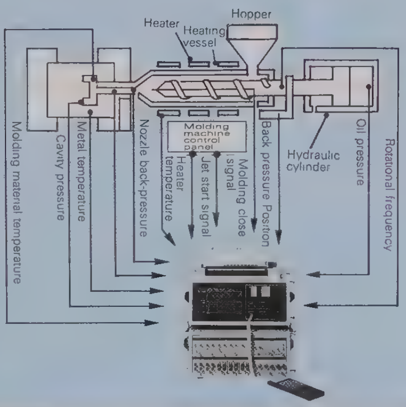
Recorders can be installed in a vehicle and measured data can be stored.

- 32 channels
- Operates on 10 to 32 V DC
- Built-in signal conditioner
- Large-capacity memory
- System start-up from main memory
- SRAM battery back-up

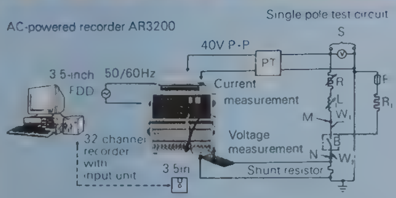


## Applications for injection molding

The AR3200 is ideal for testing injection molding machines. The AR3200, in combination with an injection-molding machine, can measure the temperature, position, pressure, and the speed essential in manufacturing plastc products.



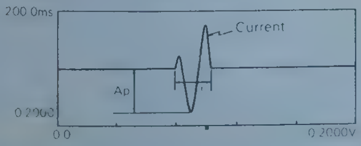
## Breaker testing



Apply power to the testcircuit, and short-circuit it between M and N; then, measure the current and voltage waveforms using the AR3200.

Measurement result

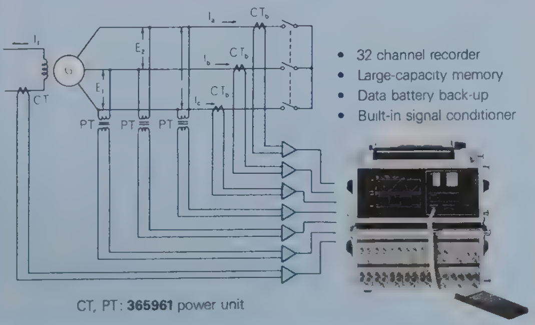
Breaking current Breaking time



## Generator short-circuit testing

Measure the three-phase current and voltage waveforms developed when the generator load is short-circuited. The AR3200 recoder can easily measure the short-circuit current amplitude using cursor functions, enabling the generator short circuit to be tested effectively.

- 32 channel recorder
- Large-capacity memory
- Data battery back-up
- Built-in signal conditioner



CT, PT: **365961** power unit

# SPECIFICATIONS

## Specifications(Mainframe)

### INPUT

**Number of Input Channels**
Up to 16 (up to 8 input modules) .....**36571☐, 36573☐**
Up to 32 (up to 16 input modules).....**36572☐, 36574☐**

### A-D CONVERSION

**A-D Converters:** Two groups (A, B)...16-channel model, four groups (A, B, C, D) ... 32-channel model.
**Resolution:** 14 bits
**Conversion speed:** 20μs.

### MEMORY

**Maximum Memory Capacity Total (for All Channels):** 0.5M words **(3657☐1)**, 1M words **(3657☐2)**,2M words **(3657☐3)**, 3M words **(3657☐4)**, 4M words **(3657☐5)**.

### GENERAL SPECIFICATIONS

**Display Tube:** 120×192mm (4-3/4×7-1/2″) electroluminescence (EL), amber 640×200 dots resolution.
**Plotter:** Four-color digital plotter using ball-point pens (black, red, green, blue ... water ink)
**FDD:** 3.5″ high-density floppy disk drive.
**Storage of System Program and Measured Data:** Ni-Cd battery backup.
**Storage of Measuring Conditions:** Up to eight conditions (Ni-Cd battery backup).
**Clock Accuracy:** Approx. ±50 ppm (Ni-Cd battery backup).
**Ni-Cd Battery Life:** Approx. one month at 0 to 40℃ (After continuous charging for 20 hours or trickle charging for 40 hours)
**Storage Temperature Range:** −30 to +60℃ (−22 to +140°F).
**Operating Temperature Range:** 0 to 50℃, 32 to 122°F(5 to 40℃, 41 to 104 °F under FDD and plotter operation).
**Humidity Range:** 10 to 90%, relative humidity (20 to 80% at FDD operation, or 40 to 80% at plotter operation).
**Power Requirements:** 10 to 32V DC, 90 to 132V AC, or 180 to 250V AC.
**Power Consumption:** 200VA max. (with all optional features).
**Dimensions:** Mainframe ... approx. 438(W)×400(D)×259(H)(17-1/4×15-3/4×10-1/2″), input unit ... approx. 438(W)×400(D)×200 or 117(H)mm (17-1/4×15-3/4×7-7/8 or 4-5/8″).
**Weight:** Mainframe ... approx. 18kg max. (39.7 lbs), input unit ... approx. 12kg (26.5 lbs), or 8.5kg (18.7 lbs), not including input modules.
**Accessories supplied at no extra cost:** Roll chart ... 1 roll, ball-point pens ... 4 pcs. (black, red, green, blue), chart roller ... 1 pc., chart guide ... 1 set, fuse ... 2 pcs., system disk ... 2 disks, blank seal ... 10 sheets, instruction manual ... 1 copy, power cord ... 1 set (for AC model), DC source connector ... 1 pc. (for DC model).

## Optional Features

### ● /REM

**1) REMOTE DISPLAY**
**Display Functions:** Digital display of measured data in designated channels, and bar graph display of signal level in designated channels.

**2) EXTERNAL INTERRUPT**
**Number of Input Channels:** Up to 8.
**Interrupt Triggering:** Fall.
**Input Signal:** TTL-level or contact signal
**Remote Control functions:** Following functions can be controlled by external interrupt signal actuated when the signal changes from H to L level.

① Measurement (START), Measurement (STOP), Data sampling (SAMPLING START)
② Increment of remote display channel No. (INCREMENT CH No.)
③ Decrement of remote display channel No. (DECREMENT CH No.)
④ Strain gauge bridge balancing (BALANCE)

### ● /EXT

/EXT also includes the function of remote display (/REM).

## Specifications (Application Packages)

### ■ WAVE-PACK (STANDARD)

### Measuring Modes

**Normal Mode:** (1) Measures in designated number of times, and the measured data are stored (1 to 3,000 times max. depending on the memory capacity), PREDISPLAY OFF.
(2) Instantaneous value in a specified channel is displayed on Remote Display (optional). Measured data are stored by depressing F6 (SAMPLING START) key, PREDISPLAY ON.
**Repeat Mode:** Measurements are repeated, and the last measured data is stored by depressing the F6 key.
**Monitor Mode:** Data for all channels are repeatedly displayed in digital.

### Memory

**Memory Setting:** Setting by measuring time, or setting by memory capacity ... 512, 1K, 2K, 4K, 8K, 16K, 32K, 64K, 128K, 256K, 512K, or 1M words/channel (limited by max. memory capacity).
- When a plotter is used:
  Use the same memory capacity as in the data quantity that is output to the plotter.
- When a program is executed:
  When the measured data is computed, a memory capacity as much as two times larger than the measured data quantity is needed.

**Writing Speed Designation:** 50, 25, 10, 5, 2.5, 1kHz, 500, 250, 100, 50, 25, 10, 5, 2.5 or 1Hz (for each group).

| | DC AMPLIFIER (365941) | ISOLATION AMPLIFIER (365944) | STRAIN AMPLIFIER (365942) |
|---|---|---|---|
| Number of Input Channels | 2 | 2 | 2 |
| Input Circuit | Unbalanced (0Ω; SHORT or 200Ω; OPEN selectable for impedance between input L and case) | Floating | |
| Measuring Ranges | ±60, 200, 600mV, 2, 6, 20V full scale. | | ±200, 600, 2,000, 6,000, or 20,000 x 10⁻⁶ strains |
| Maximum Input Voltage | 50V (DC+AC peak) | | ±10V (DC+AC peak), normal and common modes. |
| Input Impedance | 1MΩ (more than 10kΩ for overrange input) | | More than 10MΩ |
| Frequency bandwidth | DC to 20kHz (−3dB at filter OFF) | DC to 5kHz (−3dB at filter OFF) | DC to 20kHz (−3dB at filter OFF) |
| Low-Pass Filter | 10, 30, 300Hz or OFF (18dB/octave) | 10, 30, 300Hz or OFF (18dB/octave) | 10, 30, 300Hz or OFF (18dB/octave) |
| Accuracy | ±(0.2% of full scale + 50μV) with filter set at 300Hz and DC input, at 23±3℃ | ±(0.3% of full scale + 50μV) at filter 300Hz and DC input, 23±3℃ | ±(0.5% of full scale + 2μV) at filter 300Hz and DC input, 23±3℃ (not including influence of input cable) |
| Temperature Coefficient | ±(0.02% of full scale + 20μV)/℃ after automatic calibration | ±(0.03% of full scale + 20μV)/℃ after automatic calibration | Zero drift...±1μV/℃, sensitivity change... ±(0.025% of full scale)/℃ after automatic calibration |
| Input Connector | BNC | Binding post | Conforms to NDIS standard |
| Weight | Approx. 420g (0.93 lbs) | Approx. 600g (1.32 lbs) | Approx. 450g (0.99 lbs) |
| | **Type:** Direct-coupled DC type | | **Circuit:** DC bridge (auto-balancing), differential direct-coupled DC amplifier. |
| | **Linearity:** Less than ±0.01% of full scale | **Linearity:** Less than ±0.05% of full scale | **Gauge Resistance:** 120 to 1,000Ω |
| | **Maximum Common Mode Voltage:** 1.4V (DC+AC peak) at differential input impedance 200Ω (OPEN) between input L and case | **Maximum Common Mode Voltage:** 140V (DC + AC peak) | **Gauge Factor:** 200 |
| | | **Dielectric Voltage:** 1,000V AC for one minute between input and case | **Bridge Voltage:** 2V DC (remote sensing) |
| | | | **Applicable Bridge Head:** **319300** (optional accessory) |
| | | | **Linearity:** Less than 0.01% of full scale (at 20,000x 10⁻⁶ strain range |
| | | | **Automatic Balancing Range:** Less than ±4,000x 10⁻⁶ strains (at gauge resistance of 120Ω) |

**Maximum Writing Speed (For Each A-D Conversion Group):** 50kHz (for 1 channel), 25kHz (for 2 channels), 10kHz (for 4 cahnnels), 5kHz (for 8 channels).
**Pre-Trigger Setting:** 1 word to 1M words.
**Writing Method:** Channel selecting measurement in each group.
**Time Difference of Measuring Time:** Within same group ... max. 140$\mu$s, in each group ... one cycle at latest group + 140$\mu$s.

### Triggering

**Trigger modes:** ON, OFF.
**Trigger Source:** Internal (trigger channel freely selectable), external (TTL-level), or MANUAL.
**Trigger Slope:** Rise (▲) or fall (▼).
**Trigger Level:** −100% to +100% (internal, 2% steps), TTL-level (external).
**Averaging:** Linear sum or external averaging (number of averaging... 2, 4, 8, 16, 32, 64, 128, 256, times preselectable).

### Computing

**Operational Modes:** +, −, ×, ÷, SQR (square root), LOG (logarithm), EXP(exponential function), ABS(absolute value), 1st & 2nd differentials, 1st & 2nd integrals, MEAN (100-point moving average), and function key modes.
Data computation between channels or functional computation for each channel (by setting measured data, function symbols and constant symbols within 60 characters).
**Function key computations:** Y-T display ... max., min., peak to peak, average, rms value, area (waveform enclosed by 2-channel), X-Y display ... (enclosed by waveform and cursors)

### Display

**Display Formats:** Single ... 1 to 8 waveforms on a single screen (Y-T), dual ... 1 to 4 waveforms each on two screens (Y-T), quadruple ...1 waveform each on four screens (Y-T), X-Y ... X-Y display of up to 7 channels.
**Cursor:** Y-T or X-Y data of any waveform identified by the cursor can be displayed in digital.
**Reference Cursors:** Deviation between two points designated by the cursors can be displayed in digital.
**Scaling:** Scaling is possible for both vertical and time axes.
**Zoom and scroll functions:** A waveform can be zoomed in on up to 16 times its size in the direction of the vertical axis and up to 512 times in the direction of the horizontal axis. The scroll function allows waveforms to be moved along the time axis.

### Plotting

**Writing System:** X-Y plotter.
**Plotting Size:** A4, A5 (copy mode), or continuous (analog or digital mode).
**Plotting modes:** (1) Hard copy of display ... direction setting; 0° or 90°, magnification factor; 1 or 2
(2) Analog plotting of data in a designated range.
(3) Digital plotting of data in a designated range (up to 4 channels).
(4) Program list printout (all or designated programs).

**Title Plotting:** Waveform title of up to 40 characters can be entered and plotted by using programming keys.
**Duplex Plotting:** One or more measured data (waveforms) can be superimposed over an initial plot.
**Graph (Channel) Identification Numbering:** Graph (channel) identification numbering is marked along each waveform.

### Storage Medium

**Floppy:** 3.5″.
**Data Saving:** Saving by designating the case. (in case of a data overflow, the data that is completely saved is still effective)
**Saving of Panel Setting Conditions:** Conditions set from the panel can be stored.
**GPIB/RS-232-C (Optional)**
**GPIB Interface:** Meets the IEEE Standard 488-1978.
**RS-232-C Interface:** Meets the EIA RS-232-C.
**Interface Functions:** Data output, programming and program execution.

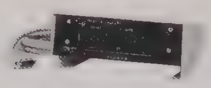
## ■ FFT-PACK (OPTIONAL)

**Analyzing:** Linear spectrum, power spectrum, power spectrum density, rms spectrum, cross spectrum, transfer function, and coherence function.
**Number of Channels:** Up to 8.
**Sampling Frequency:** 50, 25, 10, 5 2.5 1kHz, 500, 250, 100, 50, 25, 10, 5, 2.5 or 1Hz.
**Frequency Range:** fs/2.56(fs: sampling frequency).
**Data Sampling:** 512, 1,024, 2,048 points
**Frequency Resolution:** 1/200 (for 512 words), 1/400 (for 1,024 words), 1/800 (for 2,048 words) of frequency range.
**Weighting:** Hanning or rectangular window.
**Averaging Modes:** Linear sum (stable), or exponential averaging for time and frequency domain (number of averages ... 2, 4, 8, 16, 32, 64, 128 or 256 times, preselectable).
**Triggering:** Refer to Wave-Pack.
**Display Format:** Single, dual
Nyquist ... one on single screen
Array ... 2 or 3 dimensions
Number of division: 2 to 128.
**Plot:** Refer to Wave-Pack (except for "Analog, Digital" plotting).
**Measuring mode, memory and storage mode:** Refer to Wave-Pack.

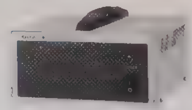
| CHARGE AMPLIFIER (365943) | F-V CONVERTER (365945A) | TC CONVERTER (365946) | TC CONVERTER (365947) |
|---|---|---|---|
| 2 | 2 | 2 | 2 |
| Unbalanced (0Ω; SHORT or 200Ω; OPEN selectable for impedance between input L and case) | Unbalanced, Direct-coupled | Floating (between channels) | |
| ±2, 20, 200, 2,000G (1 to 10 pc/G),<br>±0.2, 2, 20, 200G (10 to 100 pC/G) | 60 to 1,000 rpm<br>60 to 10,000 rpm | Type K...0 to 1,200℃,<br>Type T...−50 to +200℃ | Type J...0 to 800℃,<br>Type R...0 to 1,600℃ |
| | 50V (DC + AC peak) | 30V (DC + AC peak) | |
| | 1MΩ | More than 10MΩ (more than 10MΩ for over-range input) | |
| 1Hz to 20kHz (−3dB at filter OFF) | | DC to 10Hz (−3dB) | |
| 10, 30, 300Hz or OFF (18dB/octave) | | | |
| ±2% of full scale at filter 300Hz and 100Hz input, 23±3℃ | ±0.3% of full scale at 23±3℃ | ±(0.3% of full scale + 3℃) at 23±3℃ | Type J...±(0.3% of full scale+3℃), Type R (0 to 400℃)...±(0.3% of full scale+8℃), Type R (400 to 1,600℃)...±(0.3% of full scale+6℃) |
| ±(0.2% of full scale)/℃ after automatic calibration | ±(0.01% of full scale)/℃ | ±(0.03% of full scale)/℃ | |
| Coaxial type | BNC | Binding post | |
| Approx. 480g (1.1 lbs) | Approx. 420g (0.93 lbs) | Approx. 630g (1.39 lbs) | Approx. 630g (1.39 lbs) |
| **Measuring Pick-up Sensitivity:** 1 to 100 pc/G, selectable | **Frequency Dividing Ratio:** 1 to 1,000 (resolution 1) selectable | **TC Type:** K and T (ANSI, JIS) | **TC Type:** J and R (ANSI, JIS) |
| **Meximum Input Charge:** 20,000 pC | **Trigger Level:** Within ±5V, selectable (resolution 0.1V) (Amplitude changes of +100mV at the center of the input trigger level setpoint are required.) | **Accuracy of Reference Junction Compensation:** ±0.8℃ at 0 to 50℃ | **Accuracy of Reference Junction Compensation:** Type J...±0.8℃, Type R...±1.6℃, at 0 to 50℃ |
| **Maximum Common Mode Voltage:** 1.4V (DC+AC peak) at 200Ω (OPEN) between input L and case | **Response:** 2 pulses +20mS or 50mS second (whichever is longer). For the frequency-division N, 2N pulses +20mS or 50mS (whichever is longer) | **Common Mode Rejection:** More than 90dB at 50 or 60Hz, unbalanced resistance 1kΩ | |
| | | **Maximum Common Mode Voltage:** 140V (DC + AC peak) | |
| | | **Dielectric Voltage:** 1,000V AC for one minute between input and case | |
| | | | |
| | | | |

## Optional Features & Accessories

- **Remote display (/REM)**



- **AC adapter (365960)**



- **Bridge head (319300)**

- **DC power cord (365997)**

### AC ADAPTER (365960)

**Input:** 90 to 132/180 to 250V AC (automatic switching), 47 to 63Hz.
**Output:** 12V DC.
**Output Current:** 20A.
**Cord Length to Mainframe:** 1m (standard accessory).

### DC POWER CORD (365997)

**Termination:** Connector (to mainframe) and alligator clips (power supply).
**Cord Length:** 2m (three wires).

### BRIDGE HEAD (319300)

**Cord Length:** 5m.
**Connector:** Conforms to NDIS standard.

# AVAILABLE MODELS

### Mainframe

| Model | | Suffix Codes | Option Codes | Description | | |
|---|---|---|---|---|---|---|
| 3657 | | | | AR3200 Analyzing Recorder | | |
| | | | | Memory size | Power requirement | No. of channels |
| Memory Size, Power Requirements & No. of Channels | 11 | -B | | 2M bytes | DC | Up to 16 |
| | 12 | | | 4M bytes | | |
| | 13 | | | 6M bytes | | |
| | 14 | | | 8M bytes | | |
| | 15 | | | 10M bytes | | |
| | 21 | -B | | 2M bytes | DC | Up to 32 |
| | 22 | | | 4M bytes | | |
| | 23 | | | 6M bytes | | |
| | 24 | | | 8M bytes | | |
| | 25 | | | 10M bytes | | |
| | 31 | -1 or -5 | | 2M bytes | AC | Up to 16 |
| | 32 | | | 4M bytes | | |
| | 33 | | | 6M bytes | | |
| | 34 | | | 8M bytes | | |
| | 35 | | | 10M bytes | | |
| | 41 | -1 or -5 | | 2M bytes | AC | Up to 32 |
| | 42 | | | 4M bytes | | |
| | 43 | | | 6M bytes | | |
| | 44 | | | 8M bytes | | |
| | 45 | | | 10M bytes | | |
| Power Requirements | | -B | | 10 to 32V DC | | |
| | | -1 | | 90 to 132V AC | | |
| | | -5 | | 180 to 250V AC | | |
| Optional Features | | | /REM | Remote display (including/**EXT**) | | |
| | | | /EXT | External interrupt | | |
| | | | /DSP | Digital signal processing | | |
| | | | /GP-IB | GPIB interface | | |
| | | | /RS232C | RS-232-C interface | | |

Notes: 1. Both /**GPIB** and/**RS232C** interfaces are not compatible with a single unit
2. /**DSP** must be specified when using FFT Pack.

### Input Modules (Optional)

| Model | Name | Description |
|---|---|---|
| 365941 | DC amplifier | 2 channels (±60mV to 20V) |
| 365942 | Strain amplifier | 2 channels (±200 to 20,000 x $\mu$strains) |
| 365943 | Charge amplifier | 2 channels (0.2 to 200G) |
| 365944 | Isolation amplifier | 2 channels (±60mV to 20V) |
| 365945A | F-V converter | 2 channels (60 to 10,000 rpm) |
| 365946 | TC converter | 2 channels (JIS, ANSI...K, T) |
| 365947 | TC converter | 2 channels (JIS, ANSI...J, R) |

### Software Package (Optional)

| Model | Name | Description |
|---|---|---|
| 365986 | FFT pack | Use with /**DSP** |

### Optional Accessories

| Code | Name | Description |
|---|---|---|
| 365960 | AC adapter | AC power supply (90 to 132/180 to 250 V AC, switch selectable) for DC model |
| 365988 | Full Keyboard | Full Keyboard for AR3200 |
| 365996 | Blank panel | For panel space of a single input module |
| 365997 | DC power cord | For DC operation |
| 319300 | Bridge head | For **365942** |
| 365961* | Power unit | 2 channels each (V, A) |
| 366921* | Conversion adapter | BNC-banana |
| 366923* | Plug adapter | T-shaped |
| 366924* | BNC cable | BNC-BNC (1m) |
| 366925* | BNC cable | BNC-BNC (2m) |
| 366926* | Clip lead | BNC-clip (1m) |
| B9409LA* | Measurement lead | Banana-clip (1m) |

Note: *Also usable for 3655E and 3656

### Spares

| Name | Parts No. | Description | Order Q'ty |
|---|---|---|---|
| Roll chart | B9708AR | 20m (1 roll/unit) | 6 units |
| Ball-point pen (water ink) | B9708QA | Black (4 pcs./unit) | 1 unit |
| | B9708QB | Red (4 pcs./unit) | 1 unit |
| | B9708QC | Green (4 pcs./unit) | 1 unit |
| | B9708QD | Blue (4 pcs./unit) | 1 unit |

YOKOGAWA

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05

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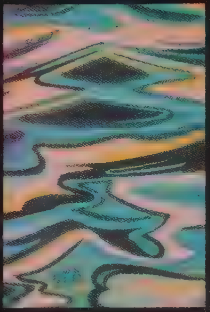
# THE NEXT WAVE OF DIGITAL OSCILLOSCOPES

YOKOGAWA ◆

## DL 1200A • Portable Digital Oscilloscopes • DL 1100

Bulletin 7001-E

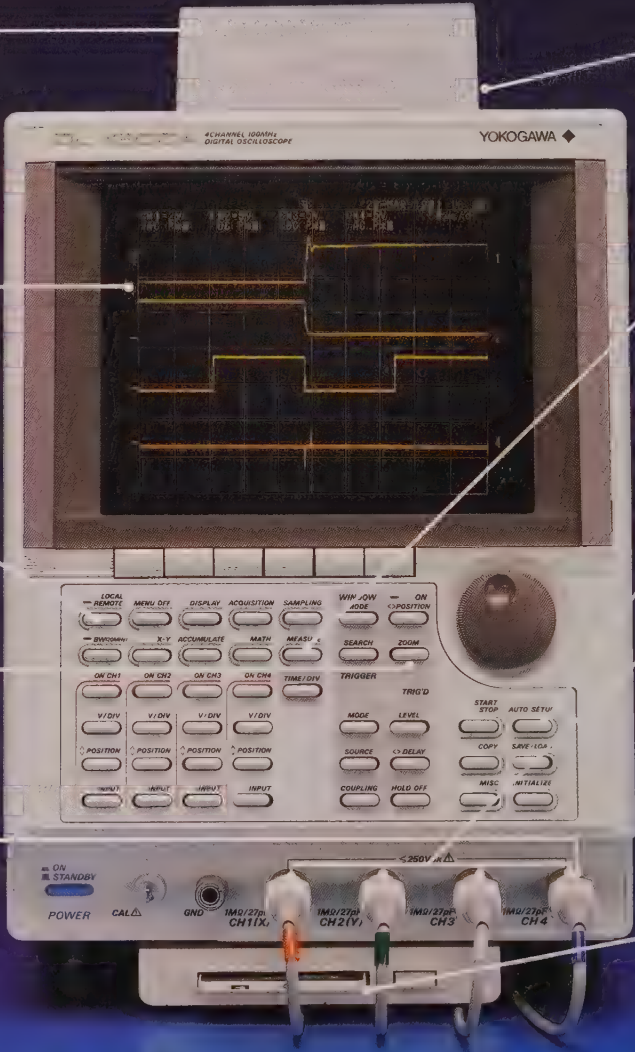


# Discover the Full Measure of Advantages in the DL 1200A & DL 1100.

*The DL1200A's 4 full channels combined with 100 MHz analog bandwidth, 100 MS/s maximum sample rate, and 128k maximum record length provides the high performance you need to solve the toughest problems The DL1100 is the 2-channel version of Yokogawa's new DL1000 series oscilloscopes. It offers the same 100 MHz analog bandwidth, with 20 MS/s maximum sample rate, and 32k maximum record length.*

*Whichever one you select, you can be sure you're getting the power and performance needed to complete the job successfully.*

*The new DL1000 series oscilloscopes combine performance, automation, and ease-of-use. You'll be amazed at their efficiency in reducing instrument setup time, increasing measurement accuracy and freeing you from the drudgery of waiting for tough-to-capture intermittent events. The DL1200A and DL1100 offer a total solution for the toughest problems in less time and with more accuracy.*



**BUILT-IN PRINTER.** Provides pushbutton documentation of waveforms, measurements and setup with date and time stamp.

**7 INCH CRT.** Displays bright, clear waveforms and instrument setup.

**PUSHBUTTON OPERATION.** Allows direct access to powerful problem solving features.

**ZOOM.** Provides up to 1000X expansion for detailed study of waveform information.

**128K RECORD LENGTH.** Permits capture of detailed information over long time intervals.

**HANDLE.** Makes it easy to carry unit as a complete portable package for bench top, factory, or field applications.

**AUTO MEASURE.** Increases measurement accuracy and repeatability.

**AUTO SETUP.** Optimizes settings and reduces setup time with one button ease.

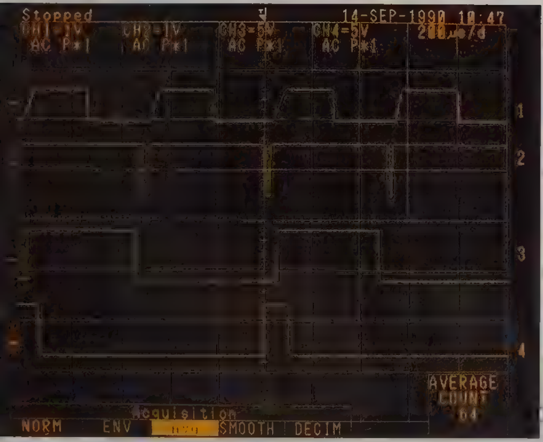
**FOUR FULL CHANNELS.** Lets you capture and view up to 4 waveforms simultaneously.

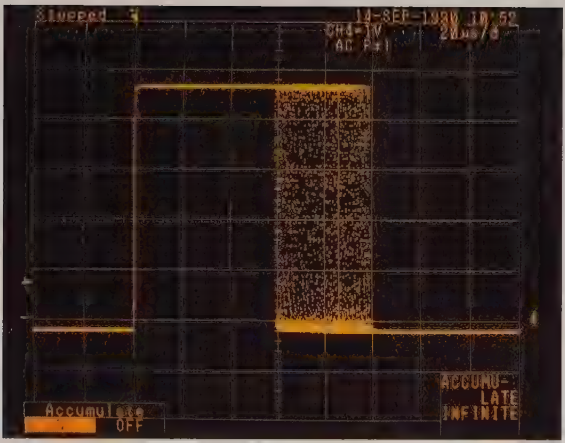
**MEMORY CARD.** Stores waveform data and front panel setups lo[illegible] term

## SPECIFICATIONS

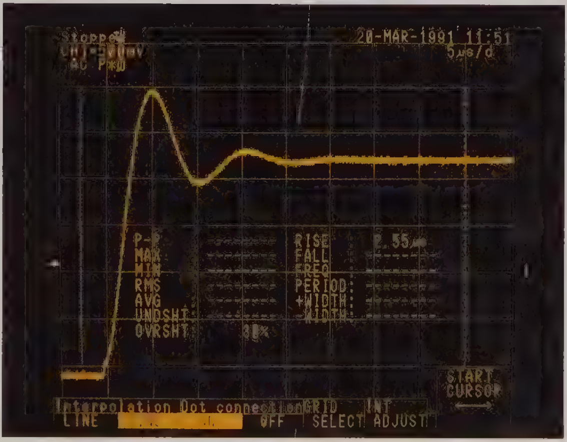
| | No. of Full Channels | Max. Sample Rate | Analog Bandwidth | Max. Record Length | Vertical Resolution | Single Shot Bandwidth | Pass/ Fail Testing | Built-in Printer (optional) | Ext. Trigger Input | [illegible] |
|---|---|---|---|---|---|---|---|---|---|---|
| **DL1200A** | 4 | 100MS/sec | 100 MHz | 128k/w | 8 bits | 40 MHz | Yes | Yes | No | Yes |
| **DL1100** | 2 | 20MS/sec | 100 MHz | 32k/w | 8 bits | 8 MHz | Yes | Yes | Yes | Yes |

**annels speed problem solving.** apture up to four simultaneous events o speed the analysis of complex digital ystems with the DL1200A's four full hannels.

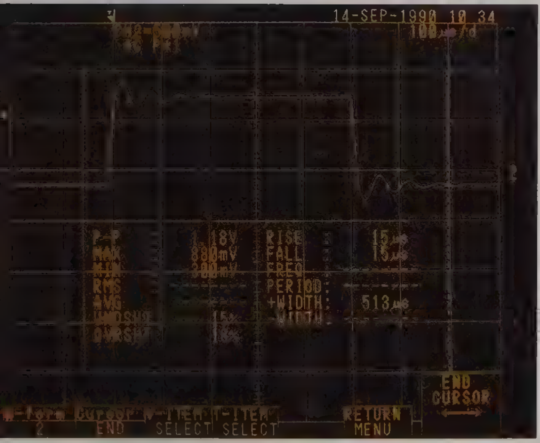




***Dynamic Accumulate captures worst case jitter.*** *Capturing worst case jitter is easy with* ***Dynamic Accumulate*** *mode. Select the period of time you want to 'accumulate' data and the jitter information is compiled on screen.*

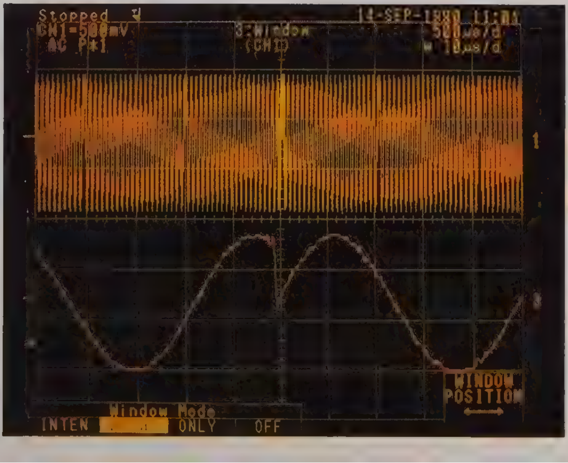


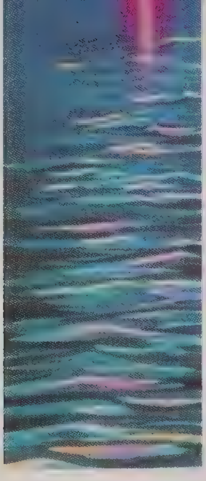
***Performance to meet all your needs, DC to 100MHz.*** *Make rise time measurements on TTL and CMOS device with the 100 MHz analog bandwidth. The display shows a rising edge captured and measured on a DL1100.*



***nproved measurement accuracy.*** *crease your measurement accuracy d repeatability using the DL1200A's 13 tomatic Measurements. Measurements de: peak to peak voltage, RMS ltage, rise time, fall time, frequency and eriod to name a few.*

*The DL1200A features an exceptionally long 128k maximum record length and 100 MS/s maximum sample rate, so you can capture a full 1 millisecond time window, single-shot phenomena, with 10 ns time resolution.*

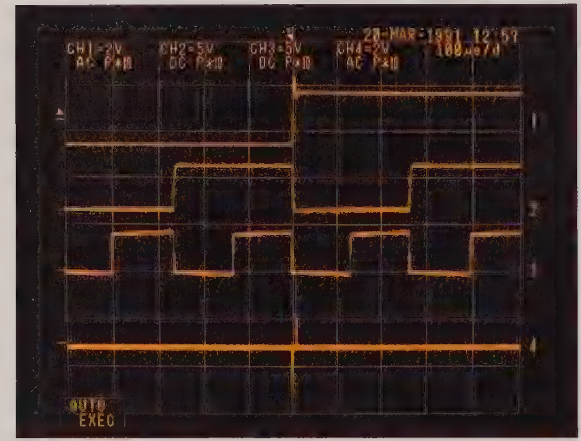




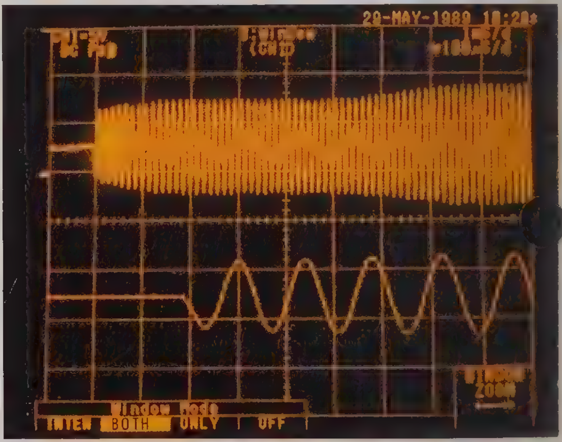
# DESIGN

## Reduce Debugging Time with 4 Full Channels

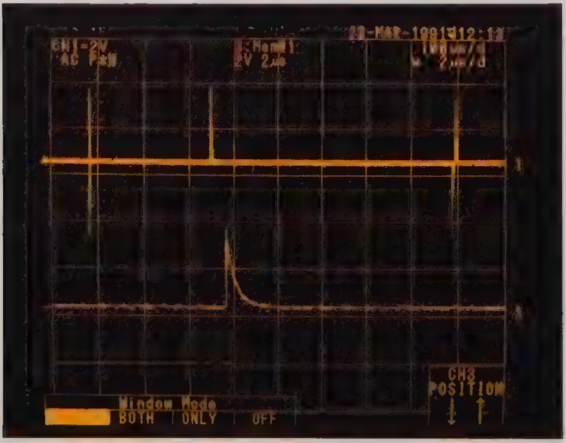
*Automatic Setup.* Reduces instrument setup time and operator error. The DL1200A and DL1100 will automatically set vertical and horizontal scaling, position, and trigger all the channels with signals applied.



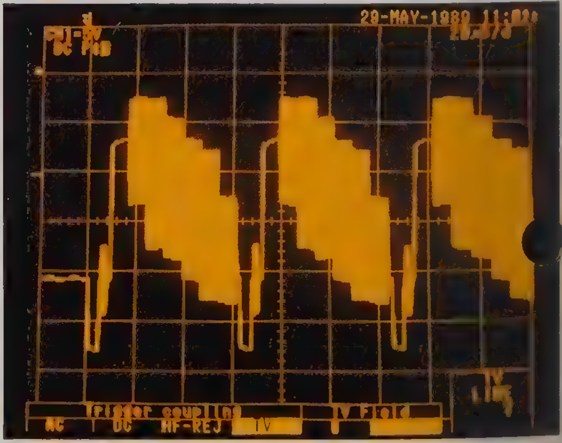
*'Zoom' in on the details, with up to 1000X expansion, and view just the event you want. Since you have 128k of waveform data, you can see all the details of events that affect your circuits.*

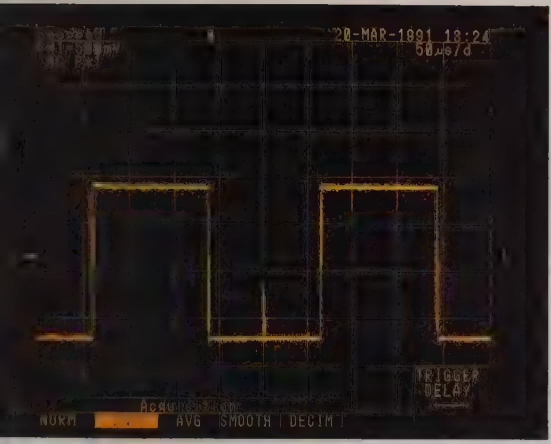


*Up to 100% Pre-Trigger.* The DL1200A allows you to select from 0% to 100% (100% corresponds to 10 div. on the display) as pre-trigger information. Now you can see what happens before the failure.



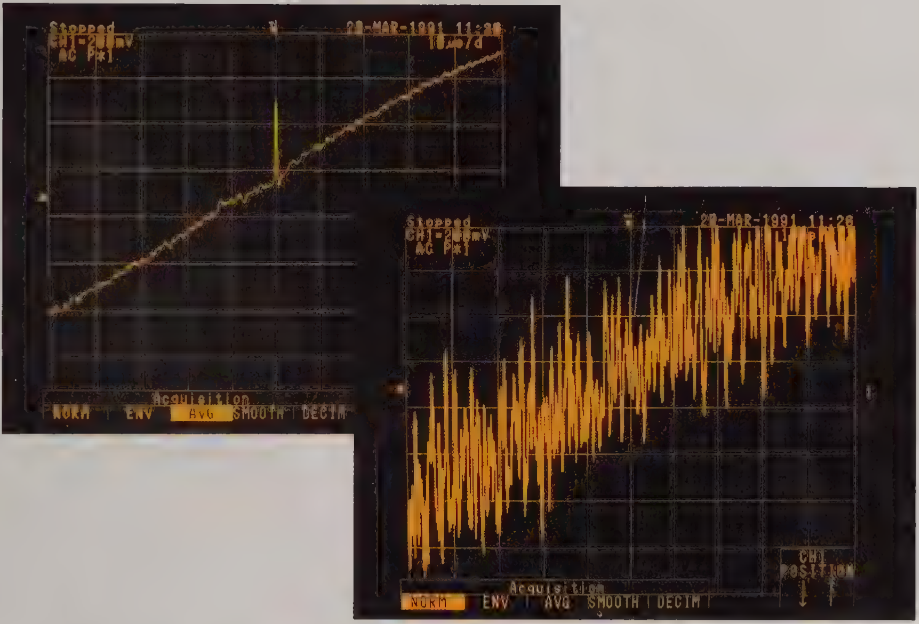
*TV Triggering.* Trigger on NTSC or PAL standard video waveform using DL1200A and DL1100 TV Trigger coupling. Selectable field and line lets you view just the information you need.





***The DL1200A's powerful acquisition modes let you see all the events of interest in your waveform.*** *To detect troublesome glitches, the DL1000 series'* ***Envelope Mode*** *lets you capture and view events as narrow as 100 ns with 100% detection confidence, regardless of sweep speed. Remove random noise and increase effective vertical resolution for repetitive signals with the* ***Averaging Mode*** *, selectable for 2 to 256 averages.*

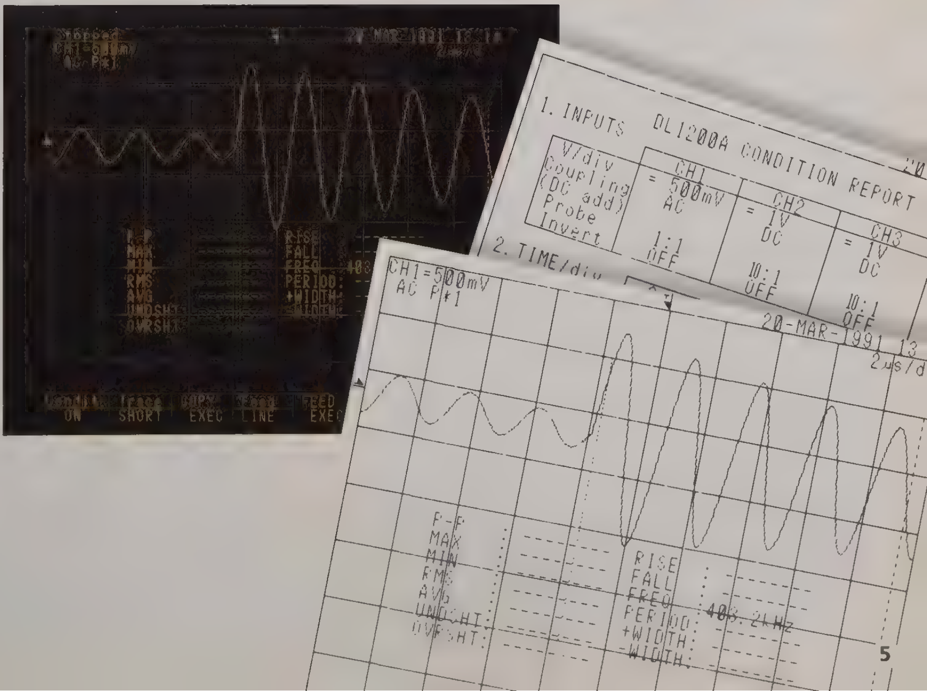
***veraging reduces signal noise to ee hidden problems.*** *For repetitive gnals, Averaging allows you to emove random noise and increase rtical resolution. Single-shot eform noise is reduced using moothing.*



***liminate the frustration of adjusting our camera!*** *The DL1200A and DL1100 ffer an optional built-in printer and emory card slot that make your camera bsolete. Just press a button for a date- nd time-stamped hardcopy of your aveforms, measurements and scope etup.*

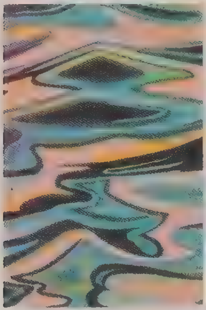
*or long term storage of your waveforms, mply download the data to a memory ard for later recall and analysis. The emory card is environmentally hard, nabling it to withstand dust, humidity, temperatures that would render a ppy disk useless.*

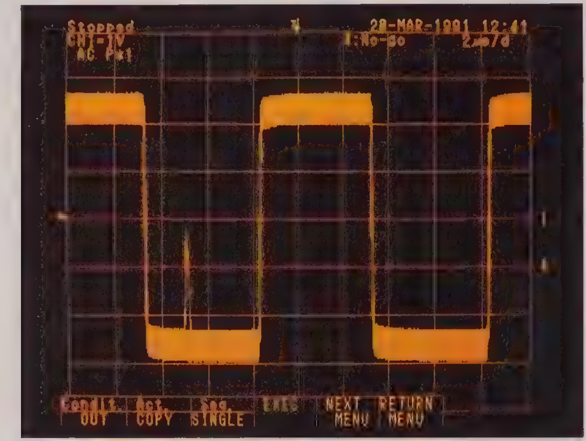
*he DL1000 Series scopes are designed nd built to Yokogawa's high quality and erformance standards, so that they will eet your needs for years to come.*



# MANUFACTURING

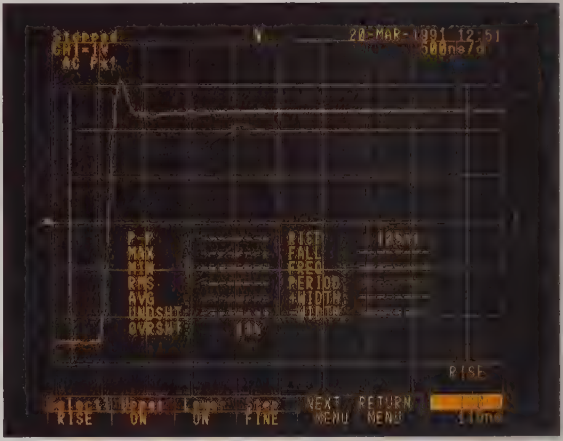
## *Reduce Time and Cost Per Test*





*The DL1200A and DL1100 feature a unique upright configuration and small footprint that make them ideal wherever bench space is at a premium. In manufacturing, automation features and full GPIB programmability make the DL1000 Series scopes a perfect solution for manual, semi-automated and automated testing.*

*For manual testing applications, the DL1200A and DL1100 are designed to increase efficiency and reduce errors. Since they are especially easy to use, the learning curve for new or infrequent operators is short, helping to improve just-in-time manufacturing flexibility and increase production output.*



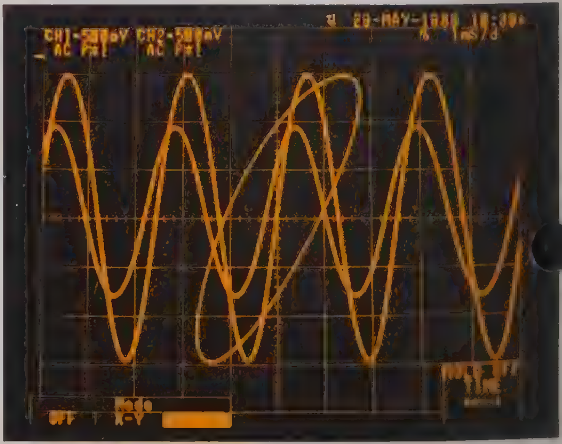
*For bench-top testing semi-automated applications, the DL1000 Series provides the answer. Select from the two automatic pass/fail testing modes, parametric testing and zone testing; compare your waveforms automatically against the limits you define. When a failure occurs, the DL1200A will act as instructed to complete any of the following actions: Printing a date and time stamped hardcopy of the waveform, saving the waveform to the optional SRAM memory card, saving the waveform to internal scope memory or providing a TTL output from the back panel.*

*The DL1200A and DL1100 include GPIB standard. They're ideal for systems applications where their built-in decision making capability minimizes bus traffic, reduces controller overhead and increases throughput to reduce time and cost per test.*

## *Display both X-Y and V-T data simultaneously.*

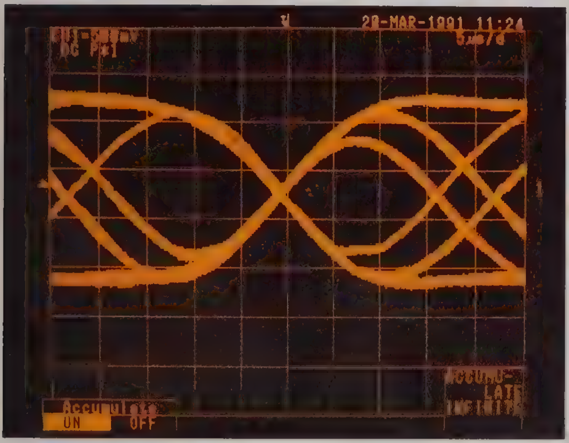
*Conduct critical phase and amplitude adjustments while viewing the results on screen. The DL1200A has the unique ability to display both X-Y and V-T information simultaneously, so you can view 2 channels of phase information and 2 channels of voltage and time information together.*

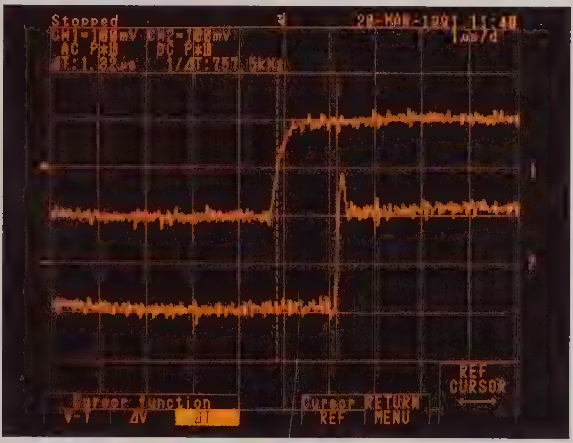
*The DL1200A also features a fast update rate – as fast as 60 updates per second – so you can see the signal change as you make your adjustments. No more going back and forth between modes to view the results of interactive phase and amplitude adjustments.*



# SERVICE TROUBLESHOOTING

## Made More Effective

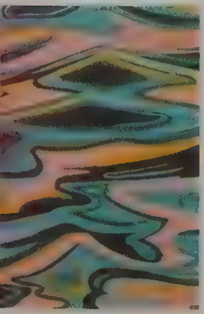




*Troubleshooting switching power supplies, A to D circuits, microprocessor controlled systems, and other complex devices require measuring multiple locations around the circuit simultaneously. Each of the DL1200A's 4 channels offers full position, attenuation and input coupling control. So you can see all the events of interest on screen at once.*

*Advanced features like **Dynamic Accumulate** allow you to capture and view worst case jitter and eye pattern displays to speed troubleshooting of state violation problems. Simply select the period of time the data is to be displayed – from .1 second to an infinite period – and let the DL1200A compile a dynamic display of your waveform changes.*

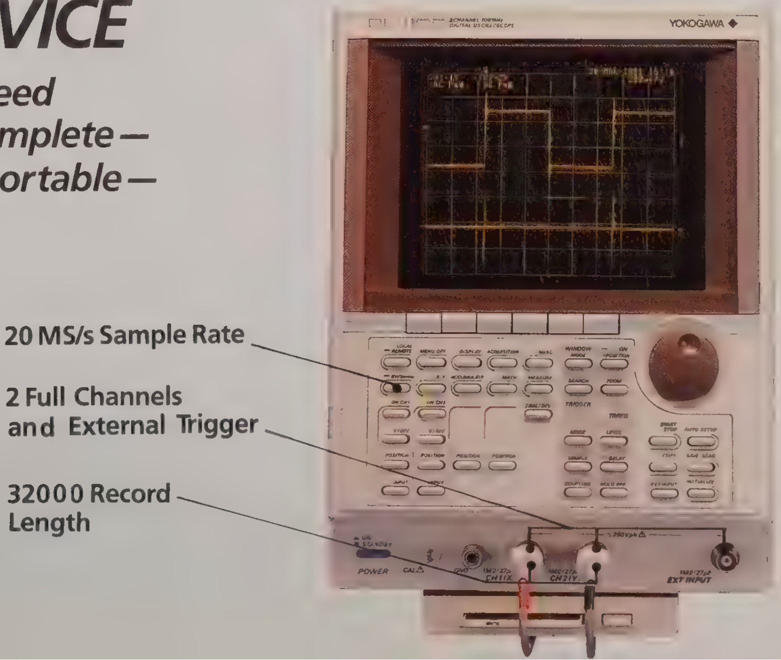
*The DL1200A provides 40 MHz single-event capture (8MHz for DL1100) with its 100 MS/s maximum sample rate in single-channel operation. Both the DL1200A and DL1100 offer 100 MHz analog bandwidth ensuring that you measure the bandwidth of your signal, not the bandwidth of your scope.*

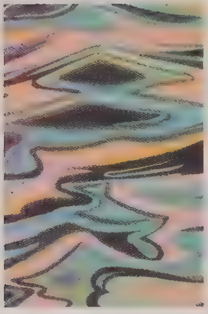


# FIELD SERVICE

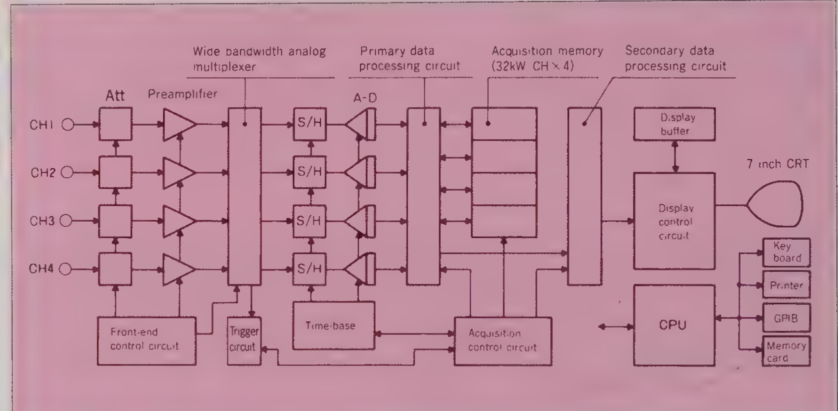
## *Everything you need comes in these complete – and completely portable – packages.*

*Whether you're traveling to the manufacturing floor or to a satellite dish in a remote desert location, you need to trans rt equipment to your work site. The DL1200A and DL1100 offer a full measure of performance in a single portable package. They're lightweight and compact, yet provide the complete solution to your waveform measurement, storage, and documentation needs.*





# TECHNICAL OVERVIEW


Wide bandwidth analog multiplexer
Primary data processing circuit
Acquisition memory (32kW CH × 4)
Secondary data processing circuit
Att
Preamplifier
A-D
CH1
CH2
CH3
CH4
S/H
S/H
S/H
S/H
Display buffer
7 inch CRT
Display control circuit
Key board
Printer
GPIB
Memory card
CPU
Front-end control circuit
Trigger circuit
Time-base
Acquisition control circuit

● DL1200A block diagram

*The DL1000 series oscilloscopes are designed for optimum performance in making your measurements. Whatever your measurement needs, DC to 100 MHz, the DL1200A and DL1100 deliver with performance and value.*

## More detailed information about your waveforms from maximum sampling speed and record length.

| No. of channels | DL1200A sample rate | DL1200A record length | DL1100 sample rate | DL1100 record length |
|---|---|---|---|---|
| 1 channel | 100 MS/s | 128k/channel | 20 MS/s | 32k/channel |
| 2 channel | 50 MS/s | 64k/channel | 20 MS/s | 32k/channel |
| 3 channel | 20 MS/s | 32k/channel | na | na |
| 4 channel | 20 MS/s | 32k/channel | na | na |

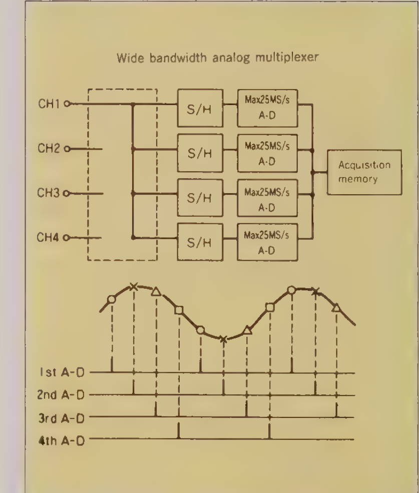
## Long Record Length Increases

### Single Shot Waveform Capture Performance

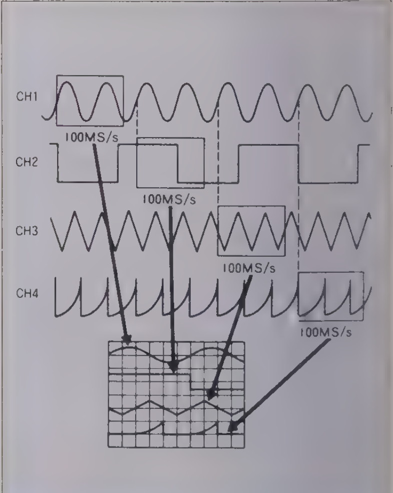
*Both the DL1200A and the DL1100 feature an exceptionally long record length, so you can capture more detail over a longer time period. This allows you to see all the detail in the signal, whether single shot or repetitive.*

### Equivalent Time Sampling extends DL1200A and DL1100 performance to 100 MHz analog bandwidth.

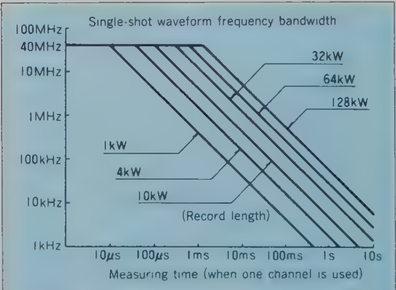
*Using equivalent time sampling techniques, the DL1200A and DL1100 performance for repetitive or periodic signals is extended to the 100 MHz analog bandwidth of the vertical amplifiers. This sampling technique allows you to reconstruct repetitive waveforms well beyond the Nyquist frequency usually associated with digital real time sampling. Another benefit derived from Equivalent Time Sampling is time resolution of up to 200 ps.*



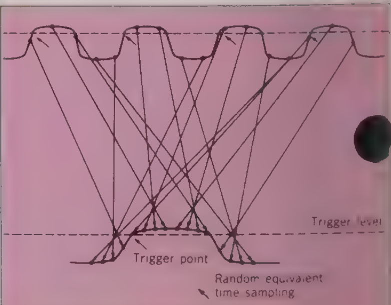
●Time sharing sampling



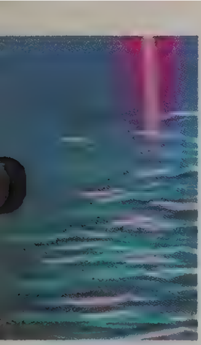
●Alternate mode



● DL 1200A single-shot waveform frequency bandwidth



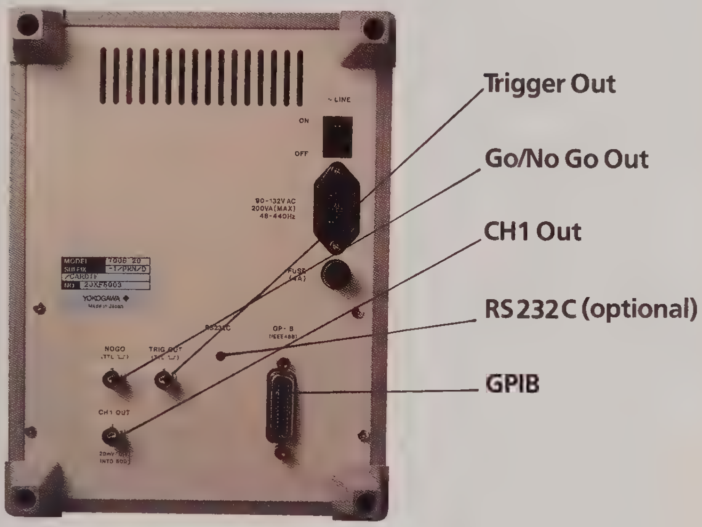
●Equivalent time sampling



# FULLY PROGRAMMABLE

## for Automated Application

*The DL1200A and DL1100 are fully programmable over either the standard GPIB or optional RS232C Port, for use with a personal computer or for automated application.*



***TRIGGER OUT.** A TTL compatible output from a back anel BNC connector allows you to synchronize riggering of an arbitrary waveform generator, or ther compatible test equipment.*

***CH1 OUT.** The analog signal from channel 1 is output from a BNC connector on the rear of the scope. (DL1200A only)*

***GO/NO GO OUT.** A TTL transition takes place when the scope makes a No Go determination.*

*ransfer waveforms captured on your 'okogawa DL1000 series scope directly o any arbitrary waveform generator ffered by Yokogawa, without a ontroller. Capture your waveforms in he field and recreate them in your lab.*

# SPECIFICATIONS

| | | *DL1200A* | *DL1100* |
|---|---|---|---|
| Vertical | Frequency bandwidth (-3 dB points)* | DC to 100 MHz (All ranges) | DC to 100 MHz (repetitive)<br>DC to 8 MHz (Single-shot)<br>EXT: DC to 50 MHz |
| | Number of input channels | 4 channels | 2 channels and EXT trigger input |
| | Vertical axis sensitivity | 2mV/div. to 5V/div. (1-2-5 steps) | CH1, 2: 2mV/div. to 5V/ div. (1-2-5 steps)<br>EXT: ± 0.5V (Full-scale) |
| | Vertical axis accuracy (directly after the auto-calibration)* | ± (2.5% of 10 div. + 1 LSB), (On reference range: 100 m/V div.) | ± (2.5% of 10 div. + 1 LSB), (On reference range: 100 m/V div.) |
| | Interchannel signal delay* | Maximum 2 ns | Maximum 2 ns (between CH1 & CH2) |
| | Interchannel isolation | -35dB (typical)(between the same ranges) | -40dB (typical)(between the same ranges, between CH1 & CH2) |
| | Maximum input voltage | 250V (DC + AC peak, maximum at 1 kHz) | 250V (DC + AC peak, maximum at 1 kHz) |
| | Input impedance | 1MΩ ± 1.5% (in parallel with approx. 27pF) | 1MΩ ± 1.5% (in parallel with approx. 27pF) |
| | Input coupling | AC, DC, GND | AC, DC, GND |
| | Band limit filter | 20 MHz (-3dB point) | 20 MHz (-3dB point only for CH1 & CH2) |
| Horizontal | Sweep time | 10ns/div. to 50s/div. | 10ns/div. to 50s/div. |
| | Time axis accuracy* | ±(0.01% + 500ps) | ±(0.01% + 500 ps) |
| | Window | Zooming and scrolling are possible. Maximum of 1,000 magnification. | Zooming and scrolling are possible. Maximum of 1,000 magnification. |
| Digitizer | Effective storage frequency bandwidth (-3dB point) | Periodic: 100MHz. Single-shot: 40MHz (Single phenomenon or alternate mode), 20MHz (2 simultaneous phenomena), 8MHz (3 or 4 simultaneous phenomena) | Periodic: 100MHz. Single-shot: 8MHz (2 simultaneous phenomena) |
| | Max. sampling rate | 100MS/s (Single phenomenon or alternate), 50 MS/s (2 simultaneous phenomena), 20MS/s (3 or 4 simultaneous phenomena) | 20MS/s (2 simultaneous phenomena) |
| | Max. memory size** | 128k word (Single phenomenon, single-shot), 64k word/ch (2 simultaneous phenomena, single-shot), 32k word/ch (3 or 4 simultaneous phenomena, single-shot), 10k word/ch (Normal) | 32k word/ch (2 simultaneous phenomena, single-shot) 10k word/ch (Normal) |
| | Vertical axis resolution | 8-bit (25 LSB/div.) | 8-bit (25 LSB/div.) |
| Trigger | Trigger mode | Normal, Auto, Auto level, single (Short memory, long memory) | Normal, Auto, Auto level, single (Short memory, long memory) |
| | Trigger source | CH1, CH2, CH3, CH4, LINE | CH1, CH2, LINE, EXT |
| | Trigger coupling | DC, AC, HF reject, TV | DC, AC, HF reject, TV |
| | TV trigger | Field and line can be specified. Corresponding method: NTSC, PAL | Field and line can be specified. Corresponding method: NTSC, PAL |
| | Trigger slope | Rise, Fall, Rise or Fall | Rise, Fall, Rise or Fall |
| | Trigger sensitivity | CH1, CH2, CH3, CH4: 1 div. (DC to 100 MHz) | CH1, CH2: 1 div. (DC to 100 MHz)<br>EXT: 100mV or 1V |
| | Trigger resolution | CH1, CH2, CH3, CH4: 1/25 div. | CH1, CH2: 1/25 div<br>EXT: 2mV or 20mV |
| | HOLD OFF time | Variable | Variable |
| | Trigger delay | 0 to -10 div. | 0 to -10 div. |
| Display | CRT | size: 7 inch (Raster scan), Phosphor color: Amber | size: 7 inch (Raster scan), Phosphor color: Amber |

| | | DL1200A | DL1100 |
|---|---|---|---|
| Communi ns | GPIB | Meets IEEE St'd 488-1978<br>Interface functions: SH1, AH1, T5, L4, SR1, RL1, PP0, DC1, DT0, C0 | Meets IEEE St'd 488-1978<br>Interface functions: SH1, AH1, T5, L4, SR1, RL1, PP0, DC1, DT0, C0 |
| | RS-232C (optional) | Meets EIA RS-232C standards<br>Transfer rate: 75, 150, 300, 600, 1200, 2400, 4800, 9600 bps | Meets EIA RS-232C standards<br>Transfer rate: 75, 150, 300, 600, 1200, 2400, 4800, 9600 bps |
| Printer (optional) | Printing system | Thermal line dot method | Thermal line dot method |
| | Dot density | 6 dots/mm | 6 dots/mm |
| | Paper width | 112mm | 112mm |
| Environmental Conditions | Ambient temperature | 5 to 40°C (Operating), -20 to 60°C (Storage, main frame only) | 5 to 40°C (Operating), -20 to 60°C (Storage, main frame only) |
| | Humidity | 20 to 85% R.H. (except printer), 35 to 85% R.H. (when using a printer) | 20 to 85% R.H. (except printer), 35 to 85% R.H. (when using a printer) |
| Others | Memory card slots | One slot memory card (Optional accessory) | One slot memory card (Optional accessory. Incompatible with the DL1200A) |
| | Signal output | Trigger output: TTL level,<br>CH1 output: Approx. 20 mV/div.<br>GO/NO-GO result output: TTL level | Trigger output: TTL level,<br>GO/NO-GO result output: TTL level |
| | Calibration output (CAL signal) | 1kHz | 1kHz |
| Ge Specifications | Power supply | 90 to 132 V AC or 180 to 250 V AC, 48 to 63 Hz | 90 to 132 V AC or 180 to 250 V AC, 48 to 63 Hz |
| | Power requirement | 150 VA Max. | 150 VA Max. |
| | Dimensions | Approx. 204(W) x 270(H) x 303(D)mm, (8 x 10⅝ x 11$\frac{15}{16}$'') | Approx. 204(W) x 270(H) x 303(D)mm, (8 x 10⅝ x 11$\frac{15}{16}$'') |
| | Weight | Approx. 8kg. (17 lbs.) | Approx. 8kg. (17 lbs.) |

*Under standard operating conditions (Ambient temperature 23 ± 2°C, Humidity 55 ± 10% R.H., power supply voltage and frequency error of less than 1% rated value) after a minimum of 30 minutes warm-up.

** Maximum displayed is: 100 kW for 1 ch single shot; 50 kW/ch for 2 ch single shot; 20 kW/ch for 3 or 4 ch single shot; 25 kW/ch at 500 μs/div.

## MODEL AND SUFFIX CODES

| Model | Suffix code | | Description |
|---|---|---|---|
| 700110 | | | DL1100 Digital Oscilloscope Series |
| 700620 | | | DL1200A Digital Oscilloscope Series |
| Power Requirements | -1<br>-5 | | 90 to 132V AC<br>180 to 250V AC |
| Power Cord | | /D | UL Standard |
| | | /F | VDE Standard |
| | | /H | SAA Standard |
| | | /J | BS Standard |
| | | /M | JIS Standard (UL + adaptor) grounded cable |
| Optional Features | | /PRN | **Built in printer |
| | | /RS232C | RS-232C interface |
| | | /CARDIF | *Memory card function |

*Memory card not included.

** Includes 1 roll chart paper.

## ARES

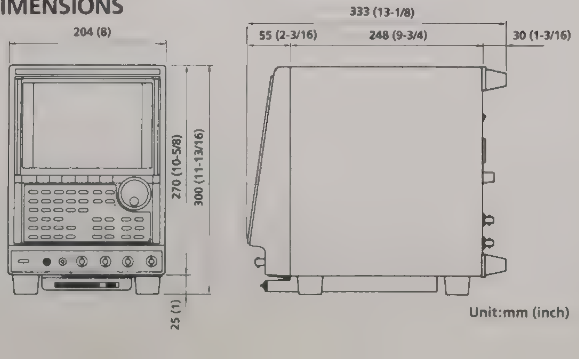
| Name | Part No. | Description |
|---|---|---|
| Roll chart | B9850NX | 30 m (one roll per unit) |
| Voltage probe | 700952 | 10 M (10:1), 1.5m (one per unit) |

Standard Accessories: (1) Fuse, (1/CH) 10:1 Voltage probes (10MΩ, 1.5m), (1) power cord, (1) DL Instruction Manual, (1) GP-IB Instruction Manual.

## OPTIONAL ACCESSORIES

| Name | Part No. | Description |
|---|---|---|
| Memory card (512k bytes) | 700904 | For memory of setting value and measured value |
| Memory card (256k bytes) | 700902 | For memory of setting value and measured value |
| Memory card (64k bytes) | 700903 | For memory of setting value and measured value |
| Lithium battery | B9586JV | For memory card |
| Miniclip converter | 700971 | Probe accessory |
| BNC adapter | 700972 | |
| Ground lead | 700973 | |
| Cleaning kit | 700921 | For CRT |

## DIMENSIONS



Unit:mm (inch)

# *Other Fine Products From Yokogawa*

YOKOGAWA

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Represented by:

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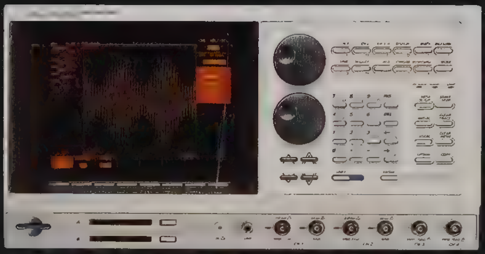
YOKOGAWA

# Digital Oscilloscope DL 2100B



DL

*The YOKOGAWA DL2100B Series is a new lineup of high-performance, two-channel digital oscilloscopes, which feature 200-Msample/s digitizing rate, 8-bit vertical resolution, and large memory capacity (128k words/channel).*

## High Performance Digital Oscilloscope

# DL2100B Series

YOKOGAWA

# Contents

P3-4 200-Msample/s, 128k word memory/channel, simultaneous 2-channel sampling

P5-6 Enhanced Trigger Set provides versatile pattern triggering modes for capturing transient and complex waveforms

P7-8 Powerful signal processing functions due to a 32-bit high-speed processor

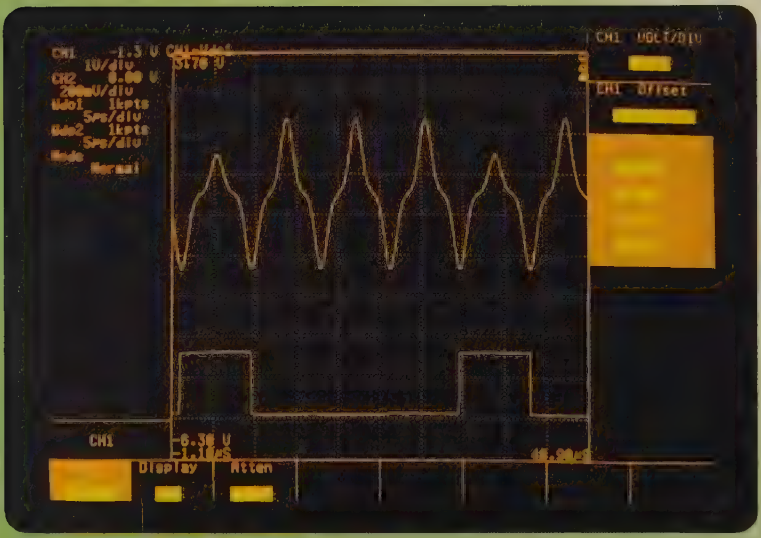
P9-10 Easy-to-operate design and man-machine communication

P11-12 Versatile waveform display modes

P13-14 Specifications

# *200-Msample/s, 128k Word Memory/Channel, Simultaneous 2-Channel Sampling*

*The DL2100B Series offers 8-bit digitizing and 300-MHz repetitive-signal bandwidth, and uses a sharp 9" amber-colored CRT display.*

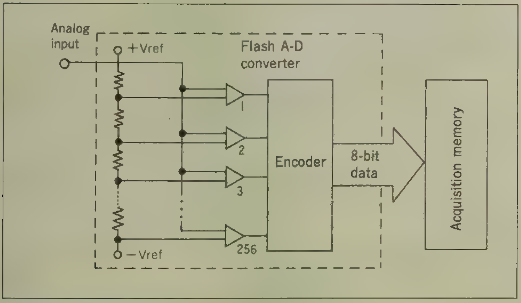


**P3-4** 200-Msample/s, 128k word memory/channel, simultaneous 2-channel sampling

## 8-bit, 200-Msample/s, simultaneous 2-channel sampling and 128k word/channel large memory.

The preformance of a digital oscilloscope is determined by A-D conversion. For this reason, the DL2100B Series utilizes high-speed flash A-D converters with 8-bit resolution and 200-Msample/s sampling capability. Simultaneity of data is preserved between the two channels by using an independent A-D converter for each channel. Further, the DL2100B Series can store up to 128k words of digitized data in large memory. This long record length is indispensable for capturing long duration single-shot events and analyzing them in detailed expansion.

For example, at 200-Msample/s (5ns sampling interval), only a 5μs time span interval of data can be observed. This is not suitable for analysis of typical single-shot signals. However, the DL2100B Series's 128k word large memory (32k words in the DL2110B) provides an observable time span of 640 μs (160 μs in the DL2110B), which enables you to grasp the waveform of interest in its entirety (See diagrams below). This makes it easy to observe waveforms which are impossible to capture with conventional digital oscilloscopes.



**● Sequential Store**

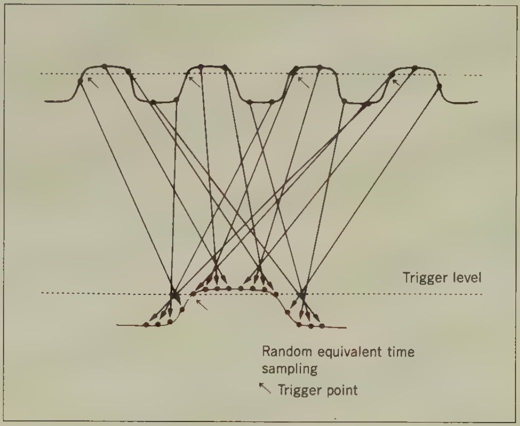
Sequential Store partitions acquisition memory into blocks and then stores a waveform in each block sequentially every time a trigger occurs.

**● Pattern Search**

Pattern search is a convenient function for locating desired waveforms from a large quantity of waveform data. It searches in succession for waveform segments which match a previously set area pattern.

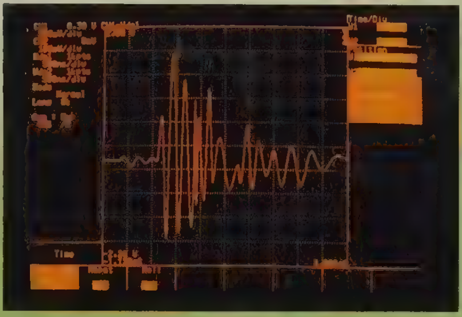
## Repetitive signals with 300MHz bandwidths (50Ω input)

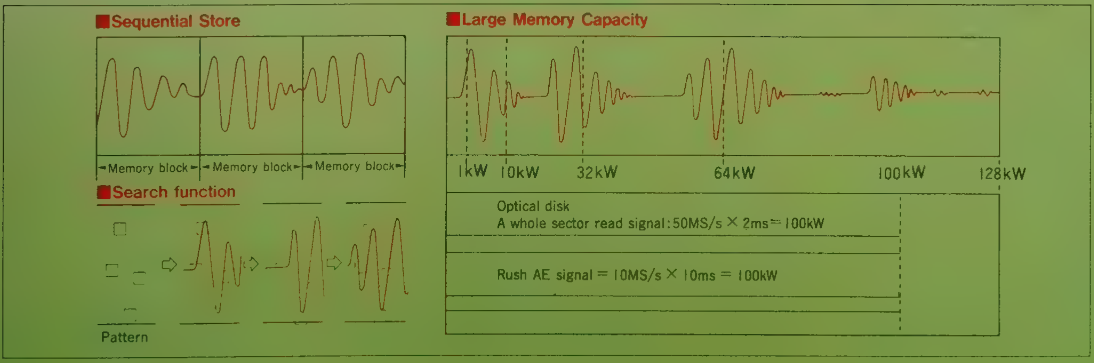
Equivalent time sampling techniques enable digitizing of repetitive signals of up to 300MHz. Furthermore, due to random sampling, pretriggering is possible. Time resolution of 100ps permits accurate observation of the waveform's rising and falling edges.

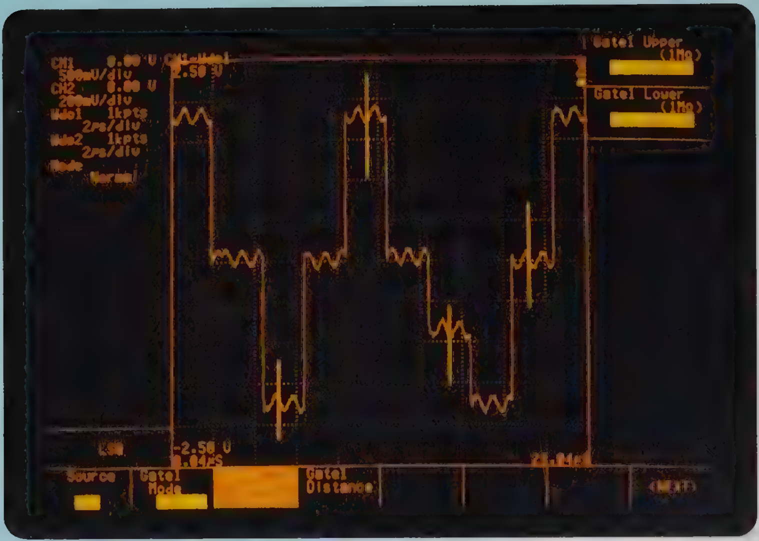


## Clear sharp waveform display

"Clear, Sharp Display"...that is the YOKOGAWA concept for the DL2100B Series. The CRT has 800 × 576 dot resolution. An amber phosphor type display helps reduce eyestrain. Further, a 32-bit display processor provides high-speed screen drawing along with sharp image definition.







# *Enhanced Trigger Set Provides Versatile Pattern Triggering Modes for Capturing Transient and Complex Waveforms*

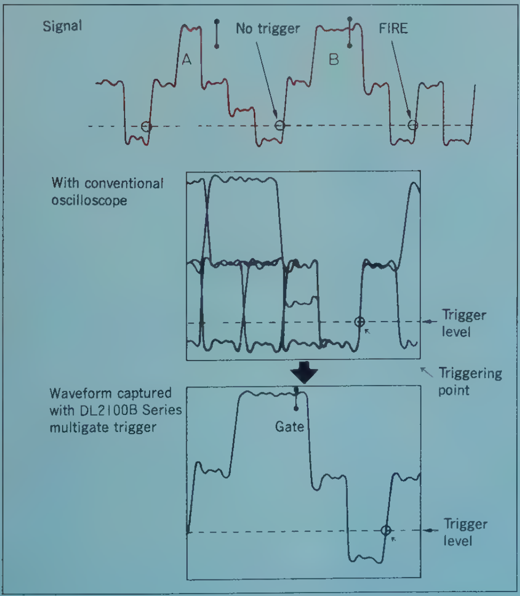
*The DL2100B Series incorporates advanced trigger set functions to capture extremely fast, complex waveforms.*

## Enhanced Trigger Set

In conventional oscilloscopes, whether digital or analog, triggering can only be done at a particular level and slope. However, because the advanced features of digital technology were included in the DL2100B Series, a powerful triggering system called the Enhanced Trigger Set (E.T.S.) was realized. Complex, high-speed waveforms which cannot be captured with conventional level triggering systems are reliably captured with the E.T.S. The Enhanced Trigger Set includes Multigate, Serial Pattern, Parallel Pattern, Combination (Serial and Parallel Pattern), Glitch, and IPD (Inter-Pattern Distance) triggering modes.

## Multigate Trigger

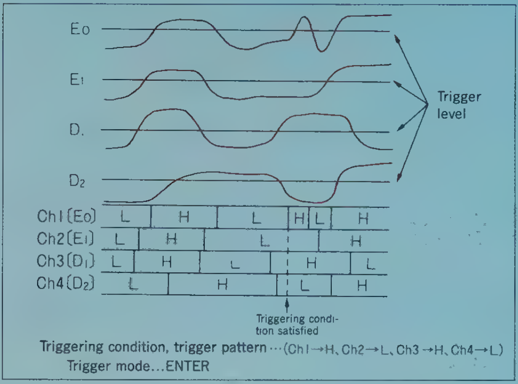
The starting point for the design of the Multigate Trigger was the desire to use pre-stored and digitized data to reliably capture waveforms which could not be captured with conventional triggering systems (such as the Local Area Network signal shown below). Triggering depends on whether or not the waveform being observed passes, through a gate set before the trigger point. Up to 4 gates can be set with a PASS (trigger if the signal passes through the gate) or BYPASS (trigger if the signal does not pass through the gate) condition for each.


Signal
A
No trigger
B
FIRE
With conventional oscilloscope
Trigger level
Triggering point
Waveform captured with DL2100B Series multigate trigger
Gate
Trigger level

## Serial Pattern Trigger

The DL2100B Series is the first oscilloscope to include a trigger function based on a serial data string. In the serial pattern triggering mode, one channel specified as the binary data is sampled according to another channel specified as the clock. The trigger is set to trip on a pre-set 8-bit serial pattern.

## Parallel Pattern Trigger



Triggering condition, trigger pattern ⋯(Ch1→H, Ch2→L, Ch3→H, Ch4→L)
Trigger mode...ENTER

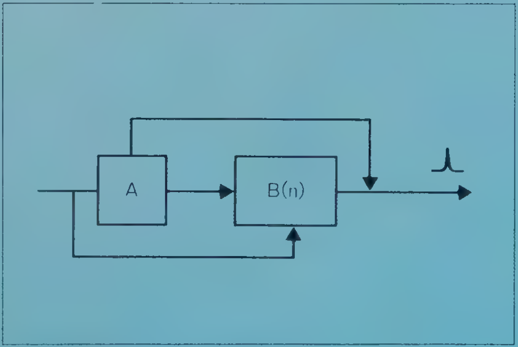
The triggering mode which demonstrates great power in digital circuit analysis is parallel triggering. The parallel pattern trigger is designed to trigger on a specified combination of High and Low logic levels on channels 1 through 4. The trigger mode can be set for any of 3 conditions relative to the set pattern: on false-to-true transition (ENTER), true-to-false transition (EXIT), or both.

## Glitch Trigger

Although glitches are a frequent cause of digital circuit malfunctions, it is impossible to trigger on a glitch with conventional oscilloscopes. However, the DL2100B Series features advanced circuit technology which enable triggering on glitches with a width as small as 5ns.

## Combination Trigger

The Combination Trigger consists of setting the trigger on a combination of two triggering conditions, A and B. There are five triggering modes: A, B, B(n), A→B, and A→B(n). The A trigger can be set as either a serial or pattern trigger, and the B trigger can be set as a parallel trigger pattern. An event count 'n' can be set up to 255.

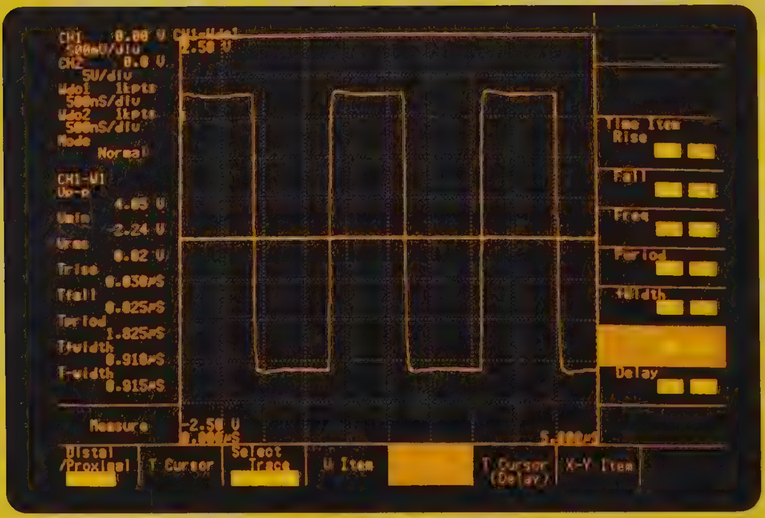


## IPD (Inter-Pattern Distance)

IPD triggers are designed to trigger on a time difference between false-to-true transition of two parallel trigger patterns A and B (ENTER only). The time difference can be set from 5ns to 20ns.

# *Powerful Signal Processing Functions due to a 32-bit High-Speed Processor*

*The DL2100B Series uses 32-bit Processors to provide a variety of powerful calculating functions and automatic measurement of waveform parameters.*



CH1 0.00 V
500mV/div
CH2 0.0 V
5V/div
Wdo1 1kpts
500nS/div
Wdo2 1kpts
500nS/div
Mode
Normal

CH1-W1
Vp-p
4.85 V
Vmin
-2.24 V
Vrms
0.82 V
Trise
0.030µS
Tfall
0.025µS
Period
1.825µS
+width
0.910µS
-width
0.915µS

**P7-8** Powerful signal processing functions due to a 32-bit high-speed processor

## Abundant Set of Computing Functions

The concept behind the development of the DL2100B Series was to design an oscilloscope which features the strong points of advanced digital technology for computing functions, while at the same time including the fast display speed of analog oscilloscopes.

Conventional digital oscilloscopes are limited more or less to the four basic arithmetic operations (+, −, ×, ÷). However, the DL2100B Series offers not only these basic computing functions, but also the following computation and signal processing functions:

> absolute value (ABS), common logarithm (LOG), exponential (EXP), square root (SQR), integral (INT), double integral (IINT), differential (DIF), 2nd-order differential (DDIF), histogram (HIST), digital filtering (FILT1, FILT2), Hilbert transform (HLBRT), phase function (PH), and programs (user-defined formulas).

The DL2100B Series is the first digital oscilloscope to use 32-bit signal processing RISC architecture to execute these computing functions at high speed.

The DL2100B is an advanced digital oscilloscope designed with YOKOGAWA's experience in signal processing technology which meets the ever more sophisticated requirements of waveform analysis.

### ■Histograms

The amplitude distribution (voltage values) is measured and a histogram of the input signal voltage is displayed. This is useful for understanding the statistical properties of signal noise and level variations.

### ■Digital Filtering

With digital filtering, Gaussian or Sharp filtering can be simulated on the acquired data. By varying the cutoff frequency, the filter constants of the circuit under design can be studied.

### ■Hilbert Transform

The Hilbert Transform enables envelope detection of an AM waveform input signal by mathematical operations. It is also applicable for measuring the instantaneous frequency of an FM waveform or for phase plane analysis to check the response of PLL circuits.

### ■FFT analysis function

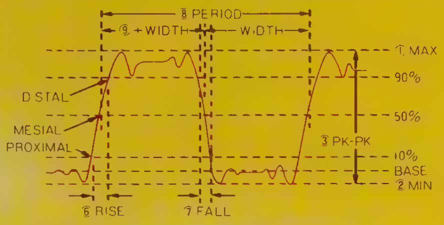
FFT analysis enables to analyze in Frequency domain.
It's very usefull to analyze spectrum of read signal from the disk or AM-modulated waveform.

1. No. of FFT points: 500, 1000, 2000
2. Window function: Rectangular and Hanning
3. FFT frequency band: 80 MHz max.
4. FFT function: Linear spectram, Power spectram Phase, etc.

## Automatic Measurement of Waveform Parameters

With just a brief and simple setup, the DL2100B can automatically measure and display various waveform parameters such as those read out on the display of an analog oscilloscope. What is more, a wide variety of parameters is available, and even the rms and average voltage values can be computed from the measured data and displayed.

Automatic Waveform Parameter Measurement



Voltage level parameters
①Maximum value
②Minimum value
③Peak-to-Peak
④RMS
⑤Average

Time domain parameters
⑥Rise time
⑦Fall time
⑧Period (frequency)
⑨Pulse width
⑩Delay

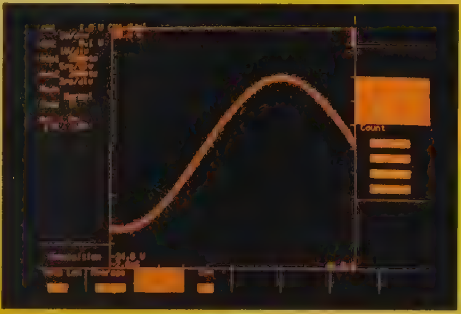
References: IEEE St'd. 194-1977
IEEE Standard
Pulse Terms and Definitions

## Autosequence (Compare)

As a result of the Compare function, a waveform matching a pre-set pattern is located and can be recorded on the built-in printer or stored on a memory card. Since the memory card has a large memory capacity of 512K bytes, unusual phenomena which occurs only occasionally can be captured and saved successively. The Compare function which is used for decisions, consists of setting eight rectangular areas. The trigger is determined effective depending on whether or not the waveform passes through these preset areas. This feature displays great power in automatic detection of aberrant phenomena.

## Accumulation

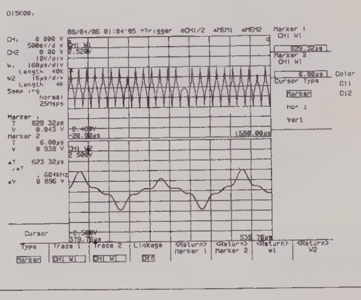
With this function, the most recent waveform is displayed on the CRT for 8, 32, 128, or an infinite number of times. This function is analogous to the variable-persistence mode of an analog storage oscilloscope and enables even more highly defined waveform observations. With the Accumulation feature, the DL2100B is ideal for measuring jitter in such things as signals of digital communication lines or read signals of magnetic disks.

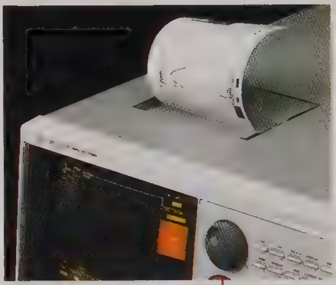


# *Easy-to-Operate Design and Man-Machine Communication*

## HP-GL Plotter Output

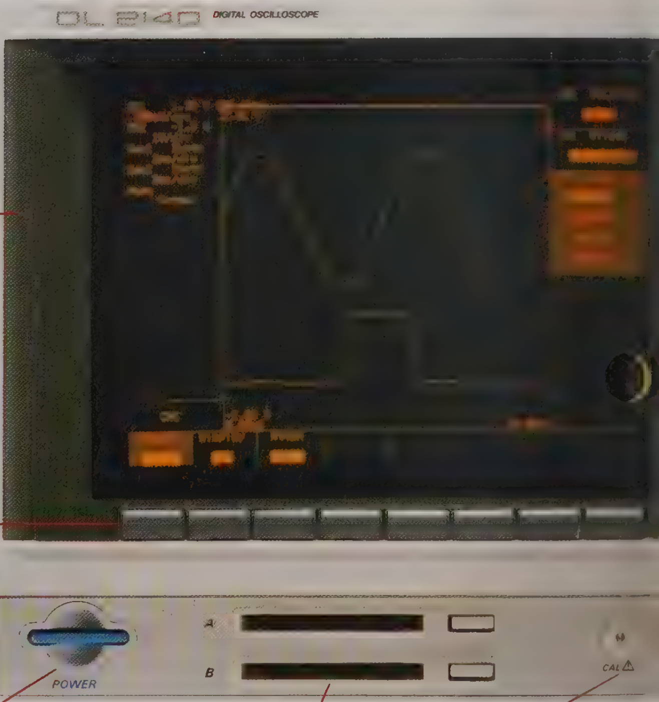
Using a HP-GL plotter or printer, a report-ready hard copy can be made without a controller.
High quality documentation in A5, A4 or A3 plot sizes can be made with ease.
HP-GL : Hewllet Packard Graphics Language





## Internal Printer (Optional)

With one touch of a button, 112mm wide copies of the CRT can be printed out. There is no need to hassle with connections to an external printer or plotter.



## 9-inch CRT

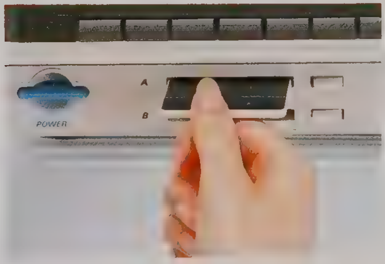
The DL2100B features a large 9-inch CRT screen so that all necessary information can be displayed. The waveform display area consists of 10 vertical and horizontal divisions for a generous viewing area.

## Soft Keys

Easy-to-operate, one-touch function keys. These Soft Keys can be used to change functions according to the menu displayed above these keys.

## Power Switch

## CAL Signal Output Terminal



## Memory Card Slot

Insertion port for memory cards used to save and load waveform data and panel setting information.

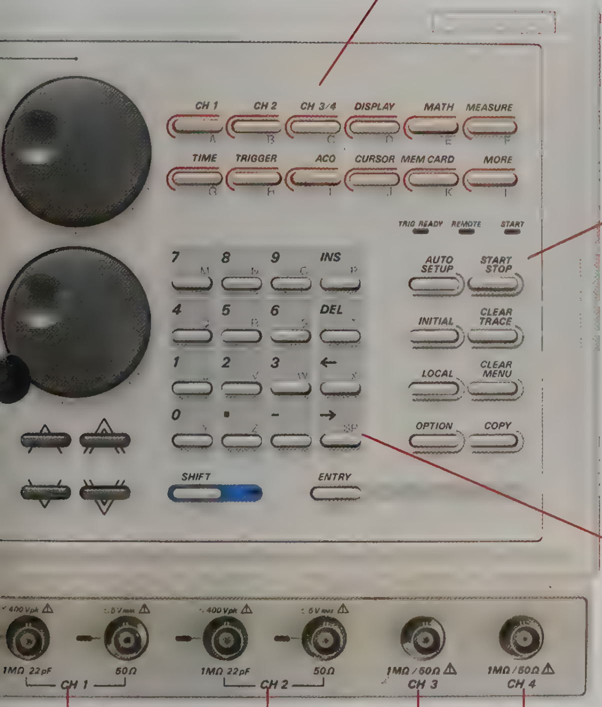
## Rotary Knob

Two rotary knobs are provided to simplify operation. For example, because simultaneous adjustment of Time/div and position is possible by using the rotary knobs, simple yet superior operation is available.

## Menu Keys

(call up corresponding setting entry displays)

**CH1:** } Individual channel setting
**CH2:**
**CH3/4:**
**DISPLAY:** Display format (including scroll and window setting
**MATH:** Waveform analysis functions for interchannel computations and digital filtering, etc.
**MEASURE:** Waveform parameter settings
**TIME:** Time axis settings (Time/Div, etc.)
**TRIGGER** Simple trigger (level trigger) settings
**ACQ:** Acquisition related settings (sequential store, etc.)
**CURSOR:** Cursor operations
**MEM CARD:** Memory card operations
**MORE:** Extended functions such as Enhanced Trigger Set, Pattern Search, Autosequence, etc.



## Function Keys

**AUTO SETUP:** Automatic setup of optimum display for input signal
**START/STOP:** Start/stop measurement
**INITIAL:** Initialize all settings (except communication-related)
**CLEAR TRACE:** Clears waveform display
**LOCAL:** Switches from remote status to local via the GPIB
**CLEAR MENU:** Erases menu
**OPTION:** Selects optional functions
**COPY:** CRT hard copy

## Numeric Keypad

## CH3/CH4 Input Terminals

Binary state display capability

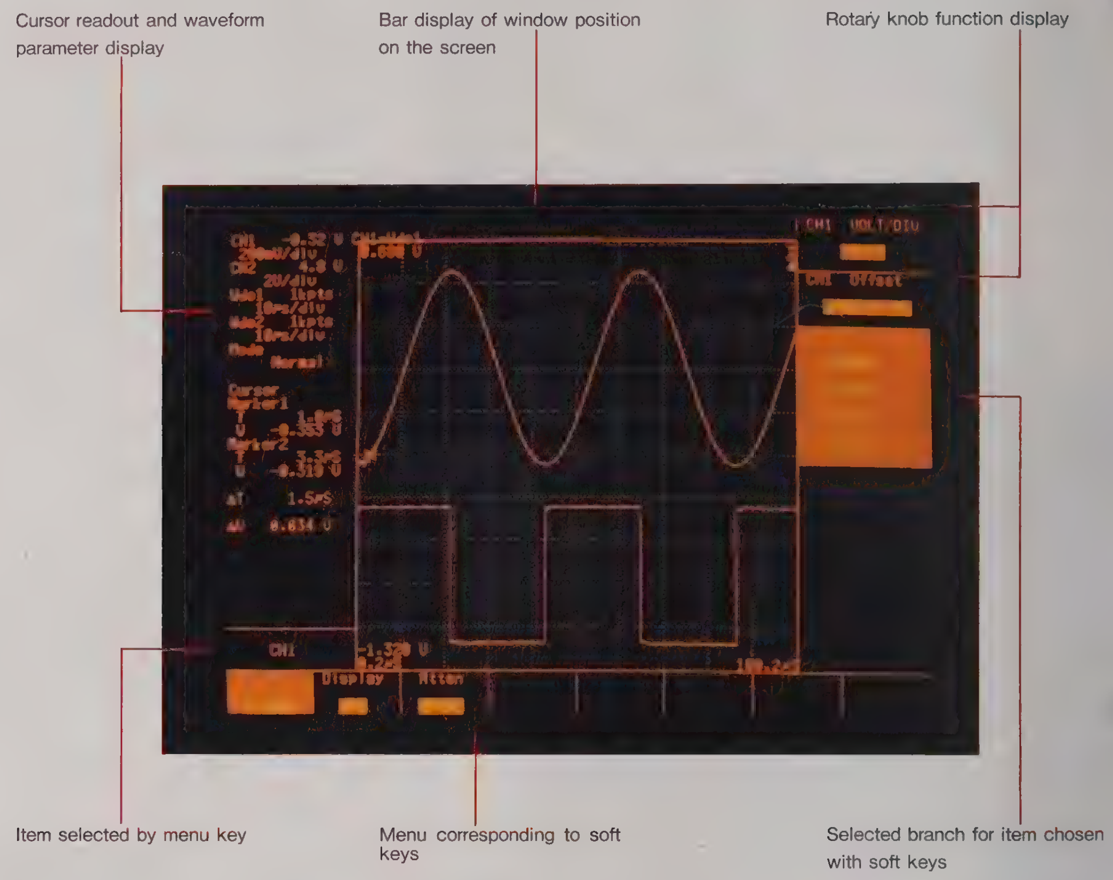
## CH1/CH2 Input Terminals

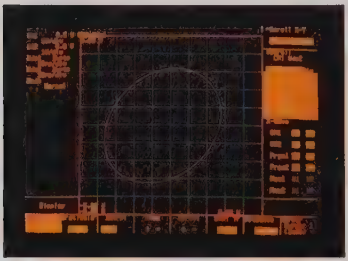
200-Msample/s, simultaneous 2-channel sampling, 8-bit vertical resolution.
Repetitive signal bandwidth of 300MHz (using 50Ω input) Input impedance of 1MΩ or 50Ω.

## Selector Keys

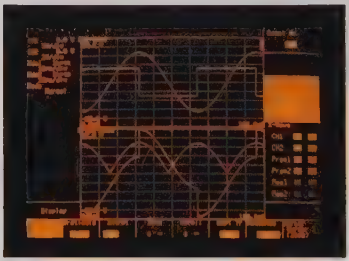
Used to set items (on right side of the CRT) selected by the Soft Keys.

# Versatile Waveform Display Modes

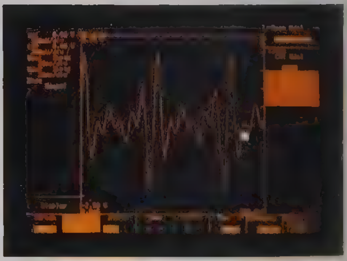

Cursor readout and waveform parameter display
Bar display of window position on the screen
Rotary knob function display
CH1 VOLT/DIV
CH1 Offset
CH1
Display
Atten
Item selected by menu key
Menu corresponding to soft keys
Selected branch for item chosen with soft keys



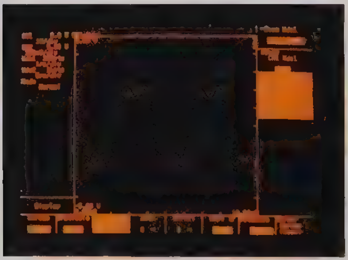
X-Y display



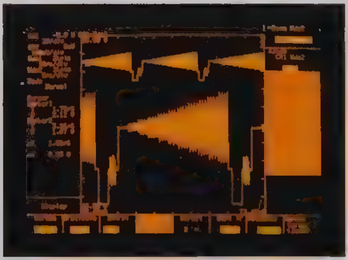
Dual display



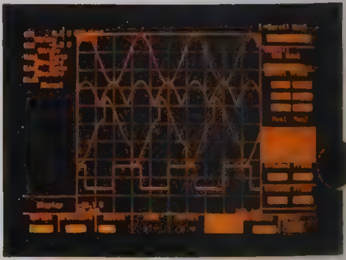
Grid off



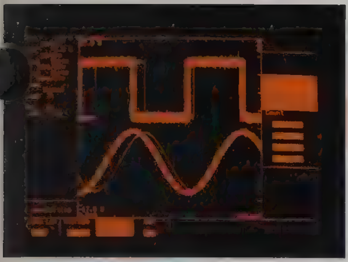
Dot display



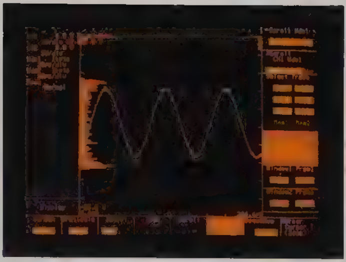
ZOOM



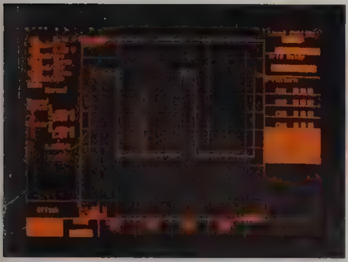
Display of 4 waveforms (up to 16 waveforms can be displayed)



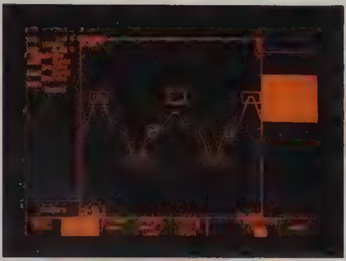
Accumulation display



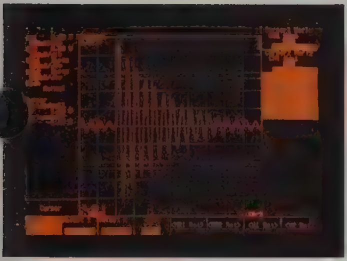
Histogram display



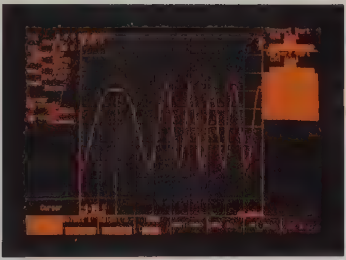
Glitch trigger



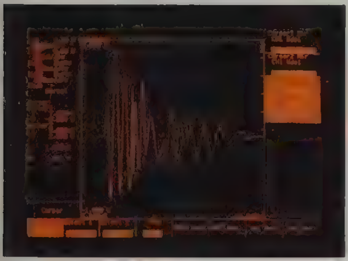
Compare mode



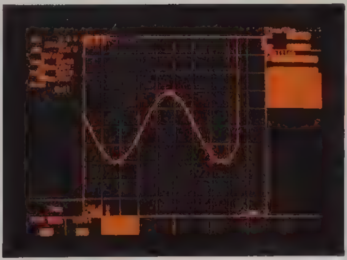
Cursor (1)



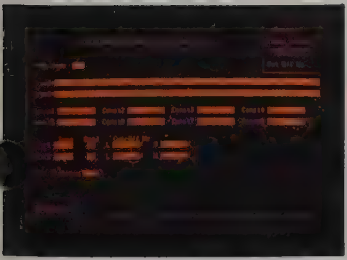
Cursor (2)



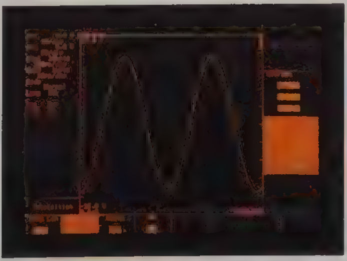
Marker indication



Roll display



Computation setup
(user definition)



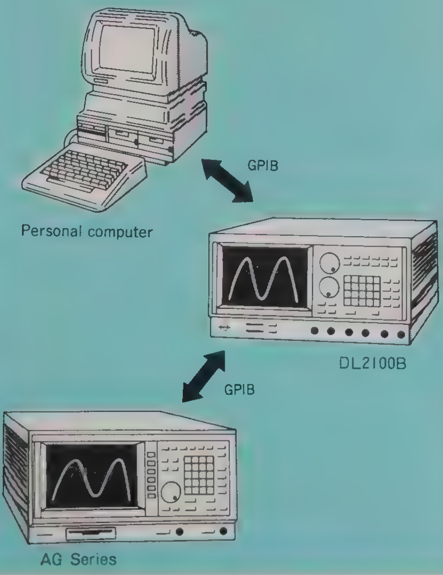
Averaged waveform

## AG2000 Series

The YOKOGAWA AG2000 Series is a new lineup of arbitrary waveform generators, which generate one- or two- channel arbitrary waveforms. AG2000 ranges DC to 50 MHz or 100 MHz with clock rate 10-bit or 8-bit D-A conversion. AG2000 Series incorporates many easy-to-use features such as large memory (128K words/channel), 9" CRT, and simple menu setting. Complex waveforms can be created by using Mathematical Formulas or "Scope Draw". Waveforms captured by other instruments can be downloaded directly into the AG2000 Series via its GPIB interface.

## GPIB (standard)/RS-232C (optional)

In the DL2100B Series, waveform data can be transferred to an external controller or key operations can be performed from an external controller via the GPIB interface (standard). By connecting to a personal computer, an automatic measurement system can be developed. Moreover, by connecting directly to the YOKOGAWA AG2000 Series Arbitrary Waveform Generator, the AG2000 Series can be used to easily reproduce waveforms captured with the DL2100B.



# SPECIFICATIONS

| | | | |
|---|---|---|---|
| Vertical (Channel 1, 2) | Frequency bandwidth (-3dB point) | DC to 200 MHz (1MΩ input)/DC to 300 MHz (50Ω input)* | |
| | Number of input channels | Two channels (up to four channels can be simultaneously displayed when including the channel 3 and 4 trigger states) | |
| | Vertical axis sensitivity | 5 mV/div to 5 V/div (1-2-5 steps)...1 MΩ input, 20 mV/div to 1 V/div (1-2-5-steps)...50Ω input ±(2% + 1 LSB) (on reference range...100 mV/div, 1 MΩ)* | |
| | Interchannel signal delay | Maximum ±500 ps (50Ω input), ±1 ns (1 MΩ input) (with respect to trigger detection between CH1 and CH2)* | |
| | Interchannel isolation | −35 dB (typical) (normal mode, between the same ranges) | |
| | Maximum input voltage | 1 MΩ input: 400 V (DC + AC peak, maximum at 1 kHz) 50Ω input: 5 Vrms, 10V peak | |
| | Input impedance | 1 MΩ ± 1% (in parallel with approx. 22 pF) (1 MΩ input) | |
| | VSWR | 1.5:1 maximum at 300 MHz (50Ω input) | |
| Horizontal | Sweep time | 10 ns/ div to 50 s/ div (1-2-5 steps), (when displaying 1k-words) | |
| | Time axis accuracy | External time base input | |
| | External time base input | 1 MHz to 100 MHz | |
| | Delay time | Post: 16 × $10^6$ data-samples. Pre: 100% of record length | |
| Digitizer | Effective storage frequency band (-3dB point) | Single-shot: 80 MHz<br>Repetitive: 200 MHz (1 MΩ input)/ 300 MHz (50Ω input) | |
| | Max. sampling rate | 2-channel simultaneous, 200 Msample/ s | |
| | Vertical axis resolution | 8-bit (25 LSB/ div), except 7-bit for channel 1 or 2 when Channel 3 or 4 trigger state on display | |
| | Memory capacity | 128 kW (DL2120B, DL2130B, DL2140B) 32 kW (DL2110B) | |
| Level trigger | Trigger source | CH1, CH2, CH3, CH4 | |
| | Trigger mode | Auto, Normal, Single, Free | |
| | Trigger slope | Rise, Fall, Rise or Fall | |
| | Trigger sensitivity (CH1, CH2) | DC to 50 MHz, 0.8 div. 200 MHz, 3 div (with 1% hysteresis) | |
| | Trigger resolution | 0.1 div. | |
| | Trigger hysteresis | 1% or 5% hysteresis (selectable) | |
| Enhanced trigger | Combination trigger | Combination of serial pattern and parallel pattern | |
| | Multigate trigger | Up to four gates may be set (DL2130B and DL2140B only). Not usable during equivalent time sampling. | |
| | Glitch trigger | Glitch width setting range: 5/ 10/ 20 ns (DL2130B and DL2140B only) | |
| | IPD trigger | Pattern-to-pattern separation setting range: 5/ 10/ 20 ns (DL2130B and DL2140B only) | |
| Display | CRT | Size: 9-inch. (Raster scan.), Phosphor color: Amber | |
| Communications | GPIB | Meets the IEEE St'd 488-1978 (JIS C1901-1987)<br>Interface Functions: SH1, AH1, T5 L4, SR1, PP0, DC1, DT0, C0 | ***A direct plotter/printer output function is available |
| | RS-232C (optional) | Meets the EIA RS-232C<br>Transfer rates...75, 150, 300, 600, 1200, 2400, 4800, 9600 bps | |
| Printer (Optional) | Printing system | Thermal line dot method | |
| | Dot density | 6 dots/ mm | |
| | Paper width | 112 mm | |
| Environmental conditions | Ambient temperature | 5 to 40°C (operating), −20 to 60°C (storage, main frame only) | |
| | Humidity | 20 to 85% R.H. (except printer), 35 to 85% R.H. (when using printer) | |
| Others | IC card slots | Two slots for memory cards (optional accessory) | |
| | Signal output | ARM OUT: TTL level, **External Trigger Output (Option): TTL level, **Compare Output (Option): TTL level | |
| | Calibrated output | 1 kHz | |
| General specifications | Power requirements | 90 to 132 V/180 to 250 V (must be specified) | |
| | Power consumption | 500 VA max. | |
| | Dimensions | Approx. 221(H)×426(W)×524(D) mm, (8-3/4×16-3/4×20-5/8") | |
| | Weight (main frame) | Approx. 19.5 kg, (42.95 lbs) | |

* Under reference operation conditions (ambient temperature 23±2°C, humidity 55±10% R.H., power supply voltage and frequency error of within 1% of rated value), after minimum 30 minutes warm-up.

**The external trigger and Compare Output functions are a paired option and are available in Models DL2120B and DL2140B only.

***A plotter which supports the HP-GL command and Thinkjet printer (Made by HP) can be used with.

## Model Classification Table

| Model | Function | | | | | | | | | | | | | | | | | | | | | | Maximum record length (1k=1000) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Computing | | | | | | | | | | | | | Triggering | | | | | | | Others | | | |
| | Arithmetic (+ − × ÷) | Absolute value (ABS) | Inverse (INV) | Logarithm (LOG) | Exponential (EXP) | Square root (SQR) | Differentiation | Digital filtering | FFT | Frequency (histogram) | Hilbert transform function/phase function | Averaging | Waveform parameter measurement | Level trigger | Parallel pattern trigger | Serial pattern trigger | Combination trigger | Multigate trigger | Glitch trigger | Inter Pattern Distance trigger | Compare (autosequence) | Pattern search | When executing acquisition only (not computing) | When computing |
| DL2110B (basic model) | *○ | ○ | ○ | | | | | | | | | ○ | ○ | ○ | ○ | ○ | ○ | | | | ○ | ○ | 32 kW | 16k points |
| DL2120B (waveform analysis model) | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | | | | ○ | ○ | 128 kW | 64k points |
| DL2130B (trigger enhancement model) | *○ | ○ | ○ | | | | | | | | | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | 128 kW | 64k points |
| DL2140B (super model) | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | 128 kW | 64k points |

* Only calculation among 2 channels is available.

## Model and Suffix Codes

| Model | | Suffix Code | Description |
|---|---|---|---|
| 7002 | | | DL2100B digital oscilloscope series |
| Functions | 10 | | DL2110B (basic model), 32k-word memory |
| | 21 | | DL2120B (waveform analysis model) 128k-word memory |
| | 31 | | DL2130B (trigger enhancement model), 128k-word memory |
| | 41 | | DL2140B (super model), 128k-word memory |
| Power requirement | | -1 | 90 to 132 V AC |
| | | -5 | 180 to 250 V AC |
| Optional features | | /PRN | *Internal printer |
| | | /RS232C | RS-232C interface |
| | | /OUT | **Trigger output, Compare output |

* Note: One roll paper is supplied as a standard accessory.

** Available in Models DL2120B and DL2140B only.

## Optional Accessories

| Name | Part Number | Description | Order Q'ty |
|---|---|---|---|
| Memory card (512K bytes) | 700904 | For memory of setting value and measured value | 1 unit (1 pc./unit) |
| Memory card (256K bytes) | 700902 | For memory of setting value and measured value | 1 unit (1 pc./unit) |
| Memory card (64K bytes) | 700903 | For memory of setting value and measured value | 1 unit (1 pc./unit) |
| Lithium battery | B9586JV | For memory card | 2 units (1 pc./unit) |
| Miniclip converter | 700971 | Probe accessory | 1 unit (1 pc./unit) |
| BNC adapter | 700972 | Probe accessory | 1 unit (1 pc./unit) |
| Ground lead | 700973 | Probe accessory | 1 unit (1 pc./unit) |

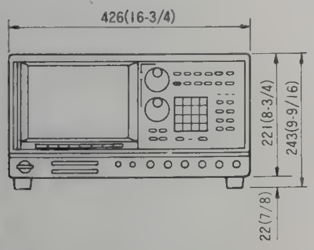
## Spares

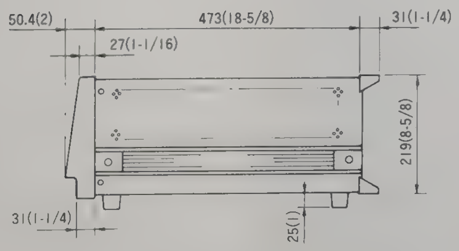
| Name | Part Number | Description | Order Q'ty |
|---|---|---|---|
| Roll chart | B9850NX | 30 m (one roll per unit) | 5 units (1 roll/unit) |
| *Probe | 700951 | 10 MΩ (10:1), 1.5 m (one per unit) | 1 unit (1pc./unit) |

* Note: Two probes are supplied as standard accessories.

## Dimensions

Unit: mm (approx inch)





# DL 2100B
## DIGITAL OSCILLOSCOPE

YOKOGAWA ◆

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YOKOGAWA

# DIGITAL OSCILLOSCOPE DL 3100B

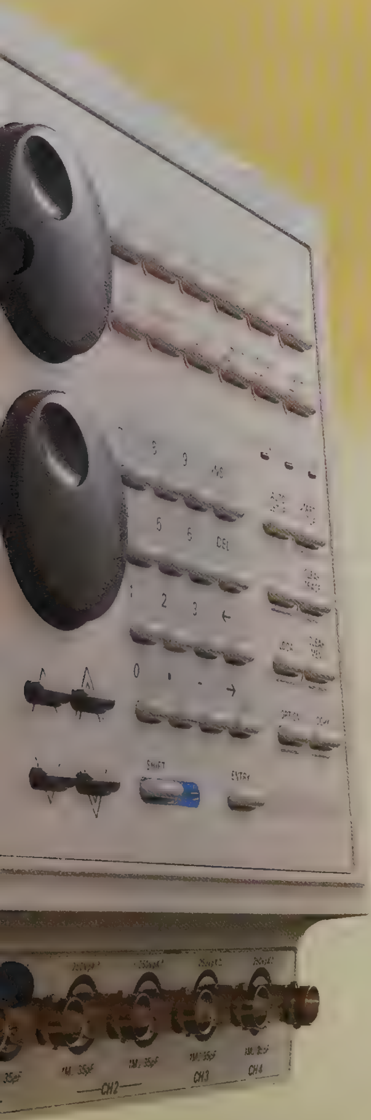
DL

*The YOKOGAWA DL3100B Series is a new lineup of high-resolution, two-channel digital oscilloscopes, which feature 25-Msample/s digitizing rate, 12-bit vertical resolution, and large memory capacity(256k words/channel).*

Bulletin 7003-E

CH1
CH2
Length
Length
Time
Normal
Time
Roll
A
B
CAL
GND

# OKOGAWA Leads Further Progress of igital Oscilloscopes.



The YOKOGAWA DL3100B Series is a new lineup of high-resolution, two-channel digital oscilloscopes, which feature 25-Msample/s digitizing rate, 12-bit vertical resolution, and large memory capacity (512k words/channel).

## 12 bits, 25-Msample/s digitizing rate

Simultaneous 2-channel sampling.

## Large memory capacity of 512 kwords/CH

512k words memory capacity is available for one channel use.
1M words memory capacity is optional.

## Enhanced Trigger Set (E. T. S.)

Complex waveforms can be reliably captured.

## Powerful computing functions

An FFT analysis function has been added.

# 25-Msample/s A-D Converters Provide High Resolution of 10 Effective Bits at 1 MHz.

## 12 bits, 25-Msample/s, simultaneous 2-channel sampling, vertical resolution 1/4096

The DL3100B uses an A-D converter with high resolution of 12 bits. Up until now, a 2-step A-D converter has been used as the high-speed high-resolution A-D converter. The 2-step A-D converter consists of 2 A-D converters in series to obtain high resolution. The input signal is sampled by the S/H circuit and held. After it is converted to m bit data by the pre-A-D converter, it is again converted to analog data by the D-A converter.

The difference between the analog signal and the input signal, the timing of which is adjusted by a delay line, etc. is amplified and converted to an n bit data signal by the main A-D converter. By synthesizing these two A-D converter outputs, the total circuit acts as an m+n bit resolution A-D converter. However, with this method, deterioration of dynamic accuracy in the high input frequency region is unavoidable. To solve this problem, YOKOGAWA developed a special 2-step A-D converter with a pipeline type T/H.

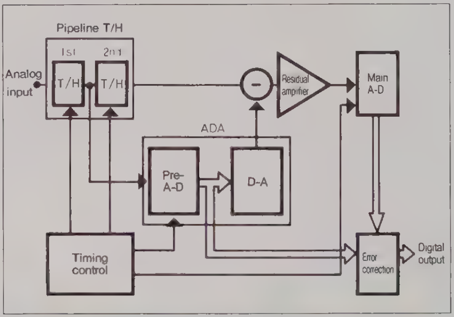
- The m bit D-A converter should have m+n bit accuracy because the difference between its output and the T/H signal is converted by an n bit A-D converter.

The DL3100B solves this problem with a newly developed D-A converter which has a settling time of 13 ns with 12-bit accuracy. YOKOGAWA's high-speed circuit technology affords superior dynamic accuracy and high resolution A-D conversion.

## YOKOGAWA-developed A-D converter

**Components**

- Pipeline T/H: Samples the input signal and holds its analog value during A-D conversion. High-speed operations are achieved using two of these track hold circuits in series.
- ADA: Consists of a 5-bit parallel type pre-A-D converter and a 5-bit D-A converter which have a high accuracy corresponding to 12 bits.
- Residual amplifier: Amplifies the difference between the T/H hold value and the ADA output value.
- Main A-D: 8-bit parallel A-D converter.
- Error correction: An adding circuit to produce 12-bit data from the pre-A-D converter's 5-bit and the main A-D converter's 8-bit data.



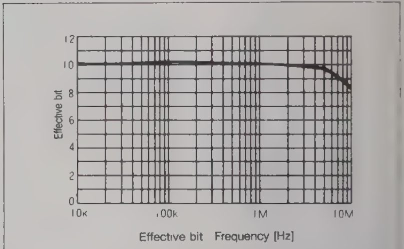
## The 10 effective bit

The DL3100B has approx. 10 effective bits (typical value) at 1 MHz as an overall characteristic (including circuits other than the A-D converter) from its input terminal. This number is the highest performance in this class of measuring instruments.

**Effective bit** = A-D converter resolution

$$-\log_2 \frac{\text{Effective value of actual quantization error}}{\text{Effective value of ideal quantization error}}$$

■The DL3100B's dynamic accuracy (typical data)



Measurement is executed by inputting a 900 mV p-p sinusoidal wave at a sample rate of 25-Msample/s in the 100 mV/div voltage axis range.

## High-sensitive differential input

The DL3100B has a highly sensitive differential input with + and − terminals. Its highest sensitivity range is 200 μV/div, with an A-D converter vertical resolution as high as 12 bits, at which point the range corresponds to 12.5 μV/div at a resolution of 8 bits.

Therefore, it is particularly effective for very small signal measurements. Furthermore, because differential inputs have a high common mode rejection ratio, it is most suitable for differential output amplifier measurements or measurements in an environment where common mode noise may have an effect.

## Large memory capacity of 512k words/channel

**When only one channel is used, 1M words of memory is available.**

Large memory capacity of max. 1M words is provided to enhance the DL3100B Series' large memory function ever further. Therefore, long duration waveform observations of up to 40.96 ms = 40 ns × 1M words are now possible with a max. sampling rate of 25-Ms[illegible]ple/s. For example, a whole TV screen of field data or a whole track of floppy disk data can be captured. As a result of only one required measurement where previously several were required, engineering productivity has improved remarkably.

(note) 1M word memory capacity is optional. Standard memory capacity is 512kW (256kW/CH).

## Complex waveforms can be captured by an enhanced trigger set (E. T. S.)

DL3100B has the following 4 kinds of trigger functions.

The DL3100B can capture complex waveforms which can not be measured by conventional oscilloscopes.

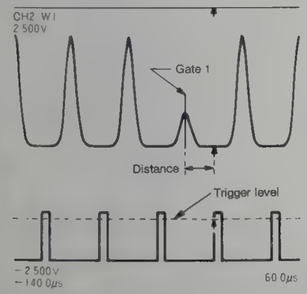
### ●Multi-gate trigger

A gate is placed in the pre-trigger region and a trigger is activated if a signal passes the gate. Up to 4 gates can be set and PASS or BYPASS conditions can be datermined for each gate.

Multi-gate triggering has made it possible to capture only the reduction in amplitude level in a periodic signal which is very difficult with conventional oscilloscopes.

The figure shows that as a signal passes the gate set at a specified distance (negative distance) from the trigger point, only level reduced waveforms are selectively captured.

**■Multi-gate waveform**



### ●Parallel pattern trigger

It is possible to trigger at conditions combining several trigger sources. A condition pattern is set by selecting the high or low signal level status for each of CH1 to CH4, and the waveform is triggered depending on whether these conditions exist or not exist or both exit and enter.

### ●Serial pattern trigger

Using a clock specified channel signal, the other channels are sampled and the trigger trips on the serial data line (8 bits).

### ●Conbination trigger

## Simultaneous operation of up to 4 DL3100B's

The DL3100B has a high-speed synchronous function which enables up to 4 DL3100B's to be connected.

Eight channel waveform observations are possible with parallel operation of four DL-3100B's. This is most suitable for such applications as multi-channel trouble observation.

## Enhanced computing functions, including an FFT analysis

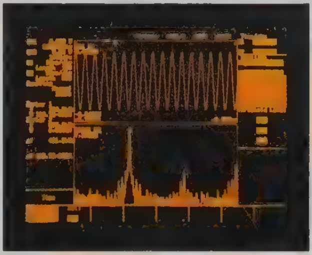
The computing functions of the DL3100B Series have been enhanced making an FFT analysis possible. As the A-D converter has 12-bit high resolution, differential operation can be used and a large dynamic range can be achieved for a spectrum data obtained by using FFT.

**Computing functions**

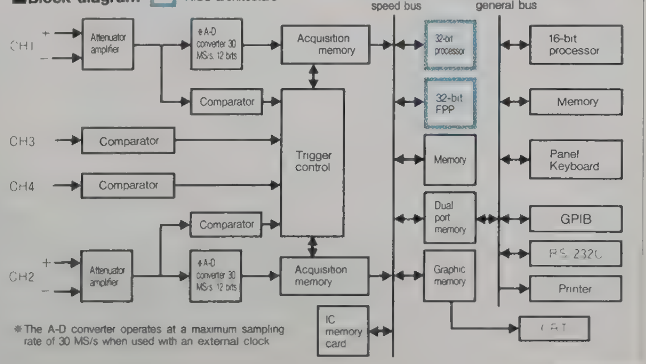
+, −, ×, ÷, absolute value (ABS), common logarithm (LOG), exponent (EXP), square root (SQR), integral (INT), double integral (IINT), differential (DIF), double differential (DDIF), histogram (HIST), digital filter (FILT 1, FILT 2), hilbert transformation (HLBRT), phase function (PH), tangent function (ATAN), linear spectrum (LS, LSPH, LSREAL, LSIMAG), power spectrum (PS), power spectrum density (PSD).

Operation expressions which combine these functions can also be used.

**■Power spectrum (PS)**



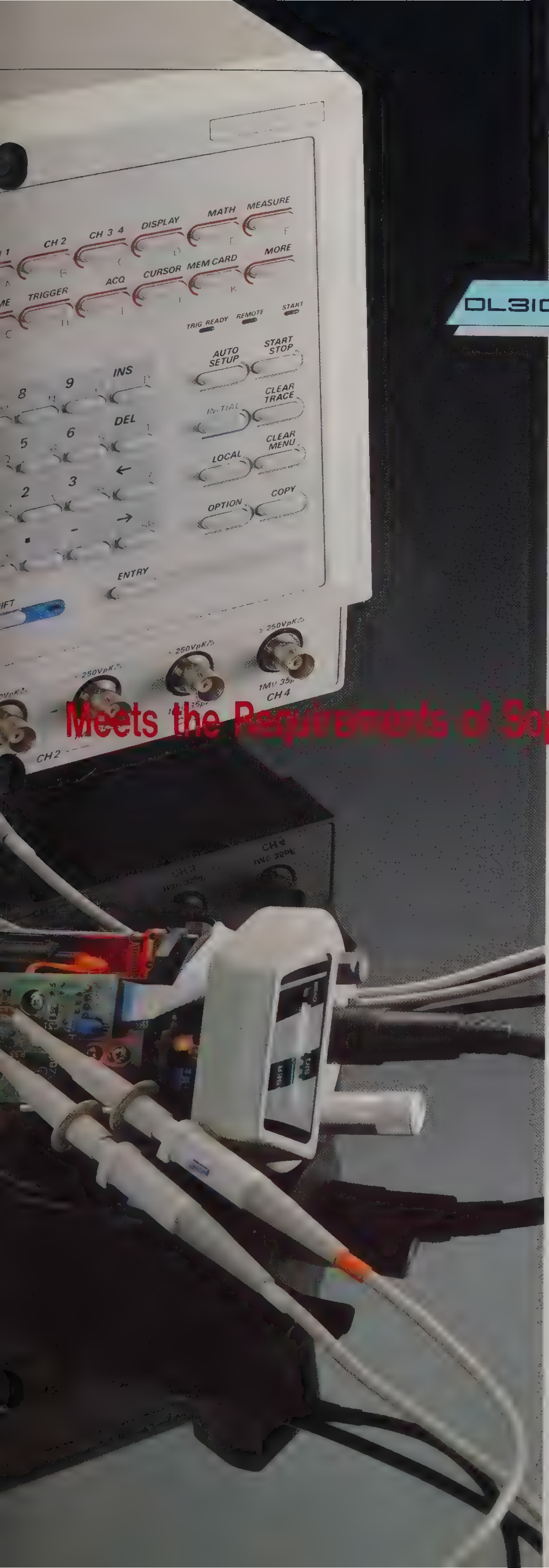
**■Block diagram**

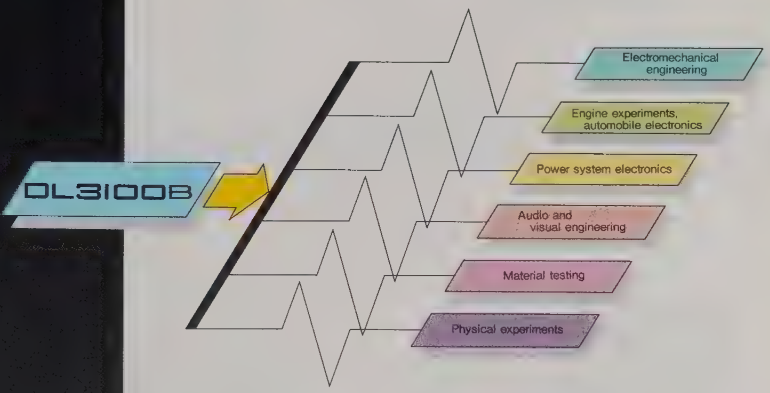


※The A-D converter operates at a maximum sampling rate of 30 MS/s when used with an external clock

3

DL 3120
12bit 25MS/s
DIGITAL OSCILLOSCOPE
POWER
CAL
GND
250Vpk
1MΩ
レーザ出射口




DL3100B
Electromechanical engineering
Engine experiments, automobile electronics
Power system electronics
Audio and visual engineering
Material testing
Physical experiments

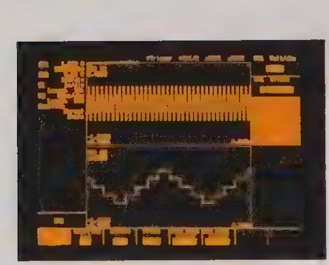
# Meets the Requirements of Sophisticated Waveform Observation.

## A high-quality digital oscilloscope capable of capturing advanced technical phenomena.

An oscilloscope is an indispensable tool for R & D in all science and industrial fields. The DL-3100B answers the diverse demands for increasingly sophisticated waveform observations required by the rapid progress of advanced technology. Its features include 12-bit high resolution (Max. 25-Msample/s) and a large memory capacity of 1M words (when one channel is used). which enable the DL3100B to exceed conventional digital oscilloscope's performance by far. For example, it possesses high vertical (voltage) axis resolution and can capture long duration single-shot (not-repeated) phenomenon even while maintaining high resolution. It inherits enhanced trigger functions and ample computing functions from the DL3100B, but has expanded their area of application, enabling it to capture phenomena which up until now could not be seen in fields ranging from electromechanical to biomedical.

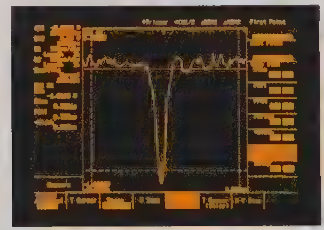
∗1MW memory capacity is optional.

# Applications in Highly Advanced Engineering Fields.



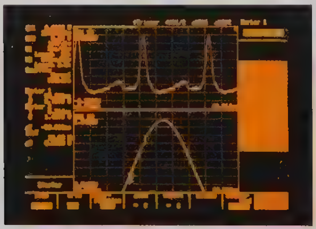
## DD motor operation analysis

The photograph shows an encoder output waveform of a direct drive motor. A digital filter is used to effectively observe the rotational speed signal as well as to evaluate the acceleration waveform by differentiation or measurement in an environment full of noise. Effective use of the large memory enables the DL3100B to capture instantaneous phenomenon superimposed on a slowly changing signal and to execute waveform cross-analysis, even in fine detail. The FFT function enables accurate vibration frequency analysis.



## Printer mechanism operation analysis

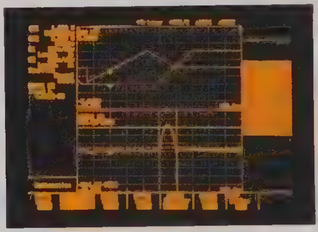
The DL3100B can be used to analyze the operation of various printer carriage systems and paper feed mechanisms. Enhanced trigger functions enable the capture of abnormal motor driving pulses or printing pulses such as step out, and also to execute analysis by making effective use of the large memory.



## Engine combustion analysis

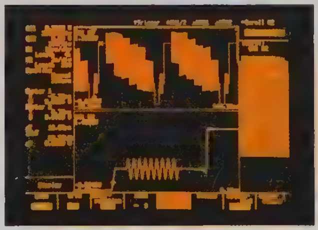
Cylinder pressure is accurately captured using 12-bit high resolution measurement.

The 1M word large memory (when one channel is used) enables data to be measured every 1 degree for approx. 28 s, even at 6,000 rpm. Both average and area values can be obtained on the spot because of the powerful computing functions.



## Switching device power loss measurement

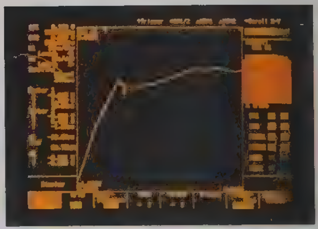
Highly accurate measurements can be carried out with 12-bit high resolution and high differential input CMRR (Common Mode Rejection Ratio). Power loss can be measured easily by using multiplication, averaging, and area computing functions. It is effectively useful for circuit breaker operation analysis and condenser facility development as well as electrical measurement of semiconductor or other power devices. FFT operation also enables distorted current waveform high harmonic analysis.



## TV signal analysis

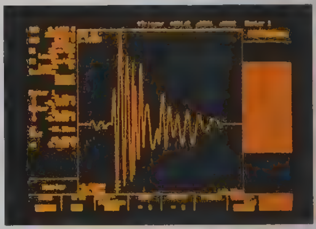
NTSC composite signals are displayed as a waveform as shown in the photograph. The large memory (*1M words when one channel is used) enables two entire fields of data to be captured (using a 28.6 MHz external sampling signal).

High accuracy measurement due to the many effective bits is a powerful tool, making the DL3100B very effective and useful in the development of digital or high fidelity TV, a rapidly growing consumer market.



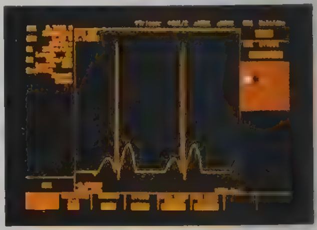
## Material and fatigue testing

With the DL3100B, both X-Y and Y-T displays are possible. Material stress-strain diagrams can be obtained by measuring the strain on a sample piece of material using a material testing machine.



## Acoustic emissions

The DL3100B captures AE (acoustic emission) waveforms and analyzes them. It executes delay time measurement between channels easily and analyzes the frequency domain with the FFT function.

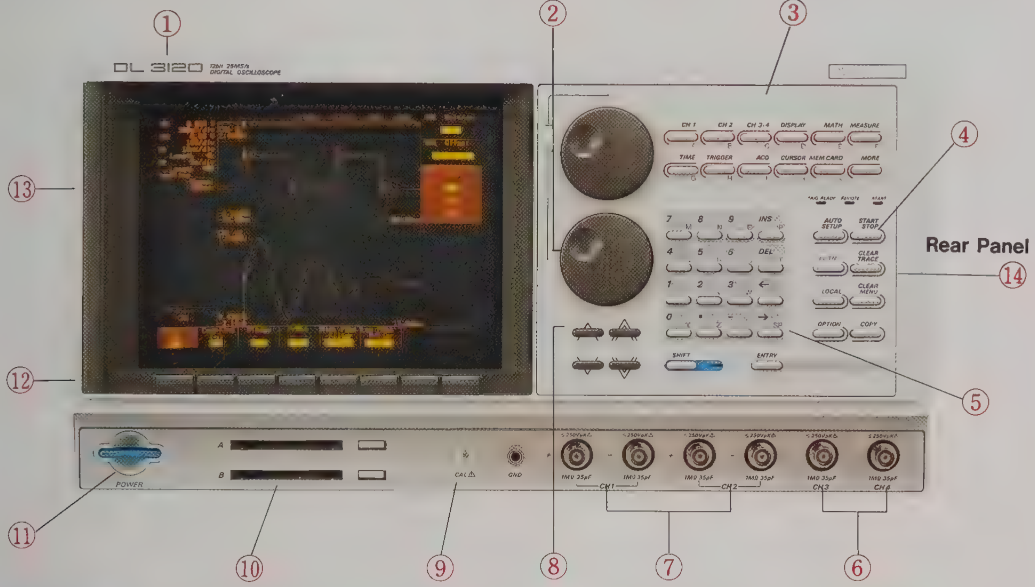


## Biomedical

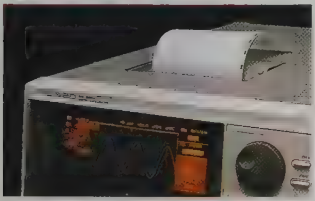
The DL3100B exhibits its power in bioelectric signal analysis due to its high vertical resolution and large memory.

∗1M word memory capacity is optional.

# Simple and Easy-to-Operate Design.



### ①Built-in printer (optional)



The CRT display can be printed out instantaneously onto 112 mm (4-7/16″) wide chart paper by simple key operation, eliminating the need for troublesome connection to an external printer or plotter.

### ②Rotary knob

Two rotary knobs are used to facilitate easy operation. Outstanding operability is obtained due to simultaneous setting of time/div. and position.

### ③Menu keys

Each appropriate panel can be displayed by pushing the relevant key when channel input condition, [illegible]play format, computing, waveform parameter, [illegible]e axis revision, trigger condition and memory capacity need to be set.

### ④Function keys

These keys are used to start/stop measurement and to output hard copy on the built-in printer. AUTO SETUP is also included to automatically provide optimum display in accordance with the input signal.

### ⑤Numerical keypad

### ⑥CH3, CH4 input terminals

H/L status display is possible.

### ⑦12-bit 2-channel simultaneous inputs with 25-Msample/s

High-sensitivity differential inputs.

### ⑧Selection keys

Setting keys for the items (displayed on the right side of the CRT screen) selected by software keys.

### ⑨Calibration signal output terminal

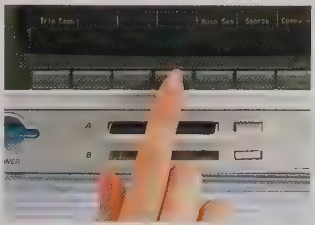
### ⑩Memory card slot

Waveform data or panel setting information is saved and loaded.

### ⑪POWER switch

### ⑫Software keys

Easy-to-use, one-touch operation keys.
Setting items are changed to match the setting panel selected from the menu.



### ⑬9-inch CRT

A 9-inch CRT capable of displaying all necessary information is used. 10 divisions in both horizontal and vertical axes determine the waveform display area and observation can be executed with ease.

### ⑭GPIB(standard)/RS-232C(optional)

In the DL3100A Series, waveform data can be transferred to an external controller via GPIB or RS-232C interface.

Using a HP-GL* plotter or printer, a report-ready hard copy can be made without a controller.

- HP-GL: Hewllet Packard Graphic Language

# Specifications

| | | | |
|---|---|---|---|
| Vertical (channel 1, 2) | Frequency bandwidth (-3 dB points) | DC to 10 MHz (20 mV/div. to 10 V/div.), DC to 5 MHz (200 µV/div. to 10 mV/div.) | |
| | Number of input channels | 2 channels differential input, + or − input coupling can be set independently. (AC/DC/GND)<br>(4 phenomena can be displayed simultaneously including CH3 and CH4 trigger status.) | |
| | Vertical axis sensitivity | 200 µV/div. to 10 V/div. (1-2-5 steps) | |
| | Vertical axis DC accuracy* (after auto-calibration) | ±(0.5% + 0.02 div.)···20 mV div. to 10 V/div. ±(2.5% + 0.02 div.)···2 mV/div. to 10 mV div. ±(5% + 0.02 div.)···200 µV div. to 1 mV/div. | |
| | Input analog filter | 6 dB/oct. roll-off characteristics, High pass filter cut-off point...100 Hz, 1 kHz, 10 kHz, 100 kHz (selectable),<br>Low pass filter cut-off point...1 MHz, 100kHz, 10 kHz, 1 kHz (selectable) | |
| | Interchannel isolation | −40 dB or less (between the same ranges) | |
| | Maximum input voltage | ± 250 V (DC + AC peak, maximum at 1 kHz) | |
| | Input impedance | 1 MΩ ± 0.5% (in parallel with approx. 33 pF) | |
| | Common mode input rejection ratio (CMRR)* | −65 dB or less (DC to 1 KHz) ··· 200 µV/div. to 100 mV/div.<br>−55 dB or less (DC to 1 KHz) ··· 200 mV/div. to 10 V/div. | |
| Horizontal | Sweep time | 4 µs/div., 5 µs/div. to 50 s/div. (1-2-5 steps) (when 1 k word is displayed.) | |
| | Time axis accuracy* | ± 0.005% | |
| | External time base input | 0 to 30 MHz, 0 dBm to 20 dBm | |
| | Delay time | Pre-trigger ··· Record length × (−100%) max., Post-trigger...16 × $10^6$ data Max. | |
| Digitizer | Max. sampling rate (2 channels simultaneously) | 25 MS/s (when an internal time base is used.), 30 MS/s (when an external time base is used) | |
| | Vertical axis resolution | 12-bit (400 LSB/div.), However, 11-bit for CHs 1 and 2 while trigger status of CHs 3 and 4 is displayed. | |
| | Memory capacity | 256 k word/CH (512 k word in the 1 channel mode). | |
| Level trigger | Trigger source | CH1, CH2, CH3, CH4, LINE | |
| | Trigger mode | Auto, Normal, Single, Free | |
| | Trigger slope | Rise, Fall, Rise/Fall | |
| | Trigger sensitivity (CH1, CH2) | 0.5 div. (with 1% hysteresis) | |
| | Trigger resolution | 0.1 div. | |
| | Trigger hysteresis | 1% or 5% hysteresis (selectable) | |
| Enhanced trigger | Combination trigger | Combination of serial and parallel patterns | |
| | Muitigate trigger | Up to 4 gates may be set | |
| Display | CRT | Size: 9 inch (Raster scan), phosphor color: Amber | |
| Communication | GPIB | Conform to IEEE St'd 488-1979. (JISC 1901 - 1987)<br>Interface function: SH1, AH1, T5, L4, SR1, RL1, PP0, DC1,DT0,C0 | A direct plotter/printer output function is available. (Note 1) |
| | RS-232C (Optional) | Conform to EIA RS-232C standard.<br>Transfer rate: 75, 150, 300, 600, 1200, 2400, 4800, 9600 bit/s | |
| Printer (optional) | Printing system | Thermal line dot method | |
| | Dot density | 6 dots/mm | |
| | Paper width | 112 mm (4-7/16") | |
| Environmental condition | Ambient temperature range | 5 to 40 ℃ (operating), −20 to 60 ℃ (storage, mainframe only) | |
| | Humidity | 20 to 85% R.H. (except for printer), 35 to 85% R.H. (when using the printer) | |
| others | Memory card slot | 2 slots ( memory card is an optional accessory ) | |
| | Signal output | ARM OUT: TTL level, COMPARE OUT (Option) : TTL level (Note 2) | |
| | Trigger output | TTL level, 50 Ω output | |
| | Multiple interconnection | Synchronous operation of one master and one to three slave instruments connected with synchronous cables (optional accessory) | |
| | Warmup time | 30 min. or more | |
| | Calibration output | 1 kHz | |
| General specifications | Power supply | 90 to 132 V AC or 180 to 250 V AC (must be specified) 48 to 63 Hz | |
| | Power cousumption | 400 VA max. | |
| | Dimensions | Approx. 221 (H) × 426 (W) × 524 (D) mm (8-3/4 × 16-3/4 × 20-5/8") | |
| | Weight | Approx. 19.5 kg (42.95 lbs) | |

* Measuring conditions Ambient temperature 23 ± 5degC, Horizontal placing

(Note 1) A plotter which supports the HP GL command and Thinkjet printer (Made by HP) can be used with.

(Note 2) Available in Model DL3120B only.

## Model classification table

| Model | Computing functions | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Arithmetic (+, −, ×, ÷) | Absolute value (ABS) | Inverse (INV) | Logarithm (LOG) | Exponential (EXP) | Square root (SQR) | Differentiation/integration | Digital filter | FFT operation | Frequency (Histogram) | Hilbert transform function/phase function | Averaging | Waveform parameter measurement |
| DL3110A (basic model) | ○ | ○ | ○ | | | | | | | | | ○ | ○ |
| DL3120A (waveform analysis model) | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |

* When performing mathematical operations, the memory length is up to 32K words.

## Model and suffix codes

| Model | | Suffix code | Description |
|---|---|---|---|
| 7003 | | ………………… | DL3100 Series digital oscilloscope |
| Function | 10 | ………………… | DL3110 (Basic model) |
| | 20 | ………………… | DL3120 (Waveform analysis model) |
| Power voltage | -1 | ………………… | 90 to 132 V AC |
| | -5 | ………………… | 180 to 250 V AC |
| Optional features | /PRN | | * Built-In printer |
| | /RS232C | | RS-232C interface |
| | /OUT | | ** COMPARE Output Function |
| | /EXTMEM | | Extension Memory (512 kw/ch) |

* One roll of paper is supplied as a standard.
** Available in Model 700320 only.

## Optional accessories

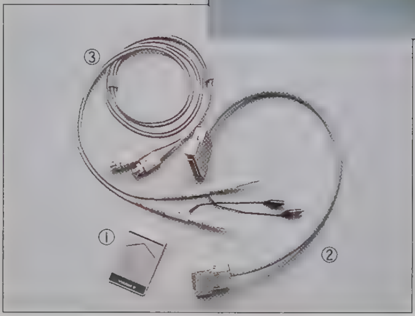
| Name | Optional code | Description |
|---|---|---|
| Memory card | 700904 | Setting & measured data, 512 K byte |
| | 700902 | Setting & measured data, 256 K byte |
| | 700903 | Setting & measured data, 64 K byte |
| Lithium battery | B9586JV | For memory card |
| Miniclip converter | 700971 | Probe accessory |
| BNC adapter | 700972 | |
| Ground lead | 700973 | |
| Synchronous cable | 700941 | |
| Differential probe | 700961 | 1 MΩ (10:1), 1.5 m |
| Voltage probe | 700951 | 10 MΩ (10:1), 1.5 m |
| Carriage | 700991 | Specialized carriage for DL and AG Series |
| Cleaning kit | 700921 | For CRT |

## Spares

| Name | Part No. | Description |
|---|---|---|
| Printer paper roll | B9850NX | 30 m (one roll per unit) |
| Differential probe | 700961 | 1 MΩ (10:1), 1.5 m (one per unit) |

## Carriage for DL3100A Series

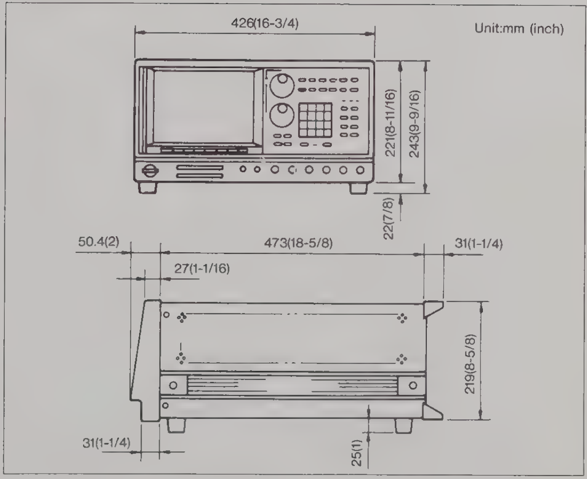
## Accessories



①Memory card
②Synchronous cable
③Differential probe

Differential probes (two pairs) are provided as a standard accessory

## Dimension



DL 3100B
DIGITAL OSCILLOSCOPE

YOKOGAWA

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Represented by:

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# 2532

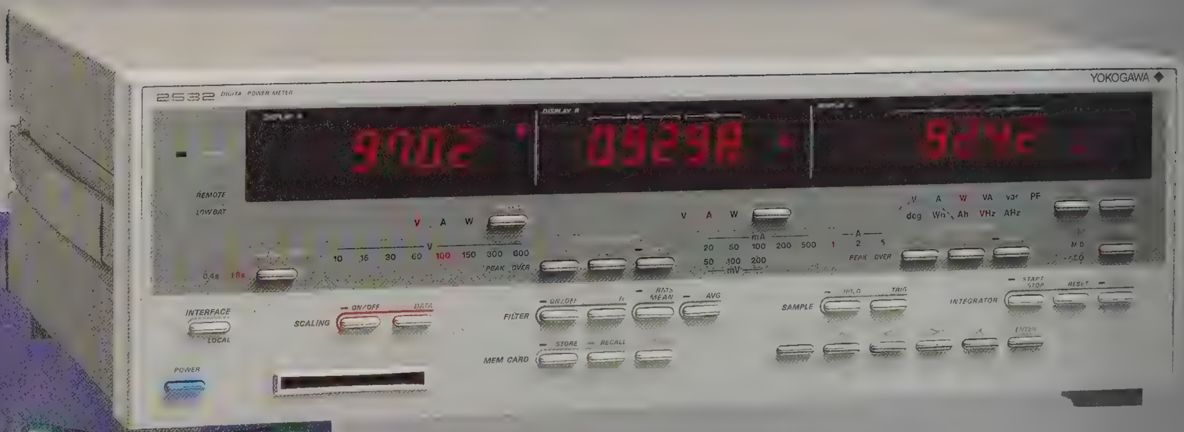
## Digital Power Meter

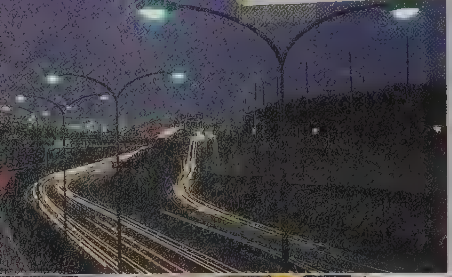
Wide bandwidth covering
DC, 20 Hz to 400 kHz

YOKOGAWA

Bulletin 2532-E

# To meet the need for power measurements over a wider frequency bandwidth: DC, 20 Hz to 400 kHz



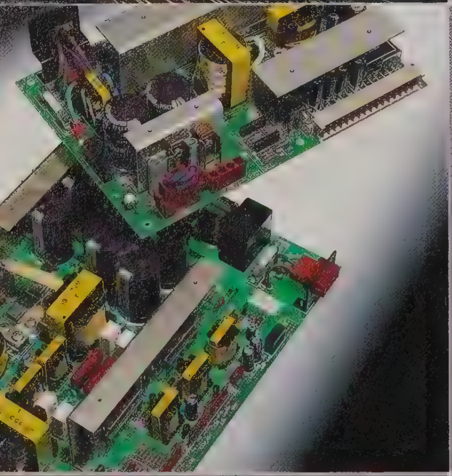


The 2532 digital power meter is YOKOGAWA's latest power meter for high-accuracy measurements over a wide frequency bandwidth. With the increasing need for energy conservation, and for smaller and lighter electric devices, power systems are required to operate efficiently at higher frequencies.

The 2532 makes it possible to measure power precisely from both DC circuits and AC circuits with AC frequencies from 20 Hz to 400 kHz.

As well as its wide frequency range, the 2532 provides a full range of measurement functions including integration and an easy-to-read display which shows three measured values simultaneously.

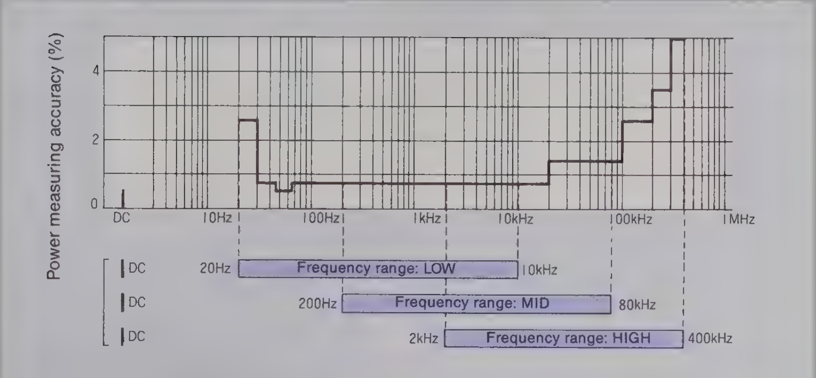
The 2532 uses the latest power measuring technologies and know-how accumulated through YOKOGAWA's long experience in this field. By combining these with state-of-the-art digital techniques, YOKOGAWA is proud to present a fully digital power meter with almost unlimited potential, the 2532.



## ■ Power measurement over a wide bandwidth: DC, 20 Hz to 400 kHz

The 2532 enables power measurements over a wide bandwidth; DC and AC frequencies from 20 Hz to 400 kHz. This makes it ideal for power measurements of devices such as electronic ballasts for fluorescent lights and the evaluation of high-frequency components and circuits such as the coils, transformers and switching power supplies.

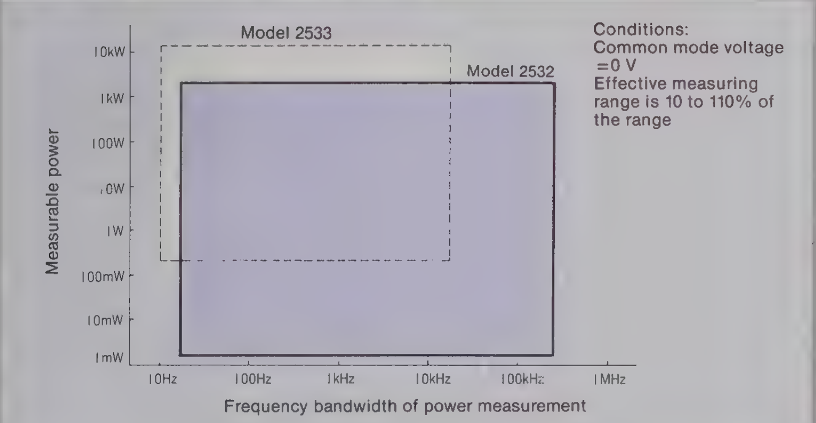
Frequency range
- HIGH: DC & 2 kHz to 400 kHz
- MID : DC & 200 Hz to 80 kHz
- LOW : DC & 20 Hz to 10 kHz



**[Power measuring accuracy vs. frequency characteristics]**

## ■ High sensitivity: power measurement possible down to 2 mW

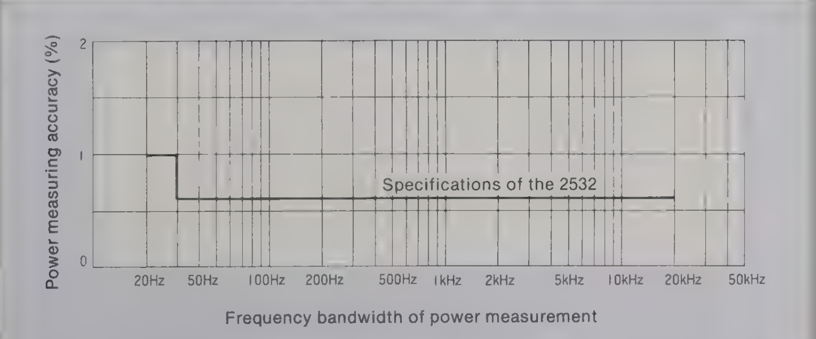
By setting the 2532 to the 10 V voltage measurement range and the 20 mA current measurement range, power levels down to 2 mW can be measured. One example of the 2532's outstanding performance is its ability to measure extremely low power, for the evaluation of dry batteries, solar batteries and magnetic materials to be used in ferrite cores.



**[Range in which power measurement is possible]**

## ■ High-accuracy measurement even with low power factor: When cos $\varphi=0$, effect of power factor is ±0.4% of range (20 Hz to 20 kHz)

The 2532 has excellent phase characteristics over a wide range of frequencies. This makes it ideal for measurements in applications where the power factor is close to 0. The power loss of electrical components with low power factors such as coils, transformers, capacitors, etc. can be measured very accurately.



**[Accuracy with power factor of 0]**

# FEATURES ..... in response to requirements in various applications

### Wide bandwidth: DC, 20 Hz to 400 kHz

The 2532 achieves excellent characteristics over a wide bandwidth of DC and from 20 Hz to 400 kHz by use of YOKOGAWA's state-of-the-art technology, including digital signal processing. This allows the 2532 to be used for the measurement of power in various conditions including half-wave and full-wave rectified waveforms, mixed AC/DC waveform and distorted waveform. It can also be used to evaluate the performance of systems such as high-frequency inverters, electronic ballasts for fluorescent lights, variable speed AC motors, switching power supplies and the coils, transformers and semiconductors used in switching power supplies.

### High accuracy

**±0.3% of reading ±0.2% of range (W, 45 to 66 Hz)**
**±0.5% of reading ±0.2% of range (W, 20 kHz)**
**±2.0% of reading ±0.6% of range (W, 200 kHz)**
**±5.0% of range (W, 400 kHz)**

As the 2532 makes possible the high-accuracy power measurement over a wide bandwidth, it is ideal for various applications from DC to high frequency.

And as the influence of the power factor is so small (±0.4% of range with cos $\varphi$=0, 20 Hz to 20 kHz), highly reliable measured values can be obtained for components with a low power factor load such as a coil, transformer, capacitor, etc.

### Wide measurement range

**8 voltage ranges:**
**10, 15, 30, 60, 100, 150, 300, 600 V**
**8 current ranges:**
**20, 50, 100, 200, 500 mA, 1, 2, 5 A**
**Power measurement range: 2 mW to 3 kW**

As the 2532 has extremely wide ranges for both voltage and current, it can be used for various applications, from extremely low power such as batteries to the very large power values of heavy electrical equipment including motors and transformers. Especially, as the measurement of very low power values as small as 2 mW is possible, the 2532 is ideal for the evaluation of various magnetic materials such as amorphous and crystalline ferrite.

### External shunts for extended input range

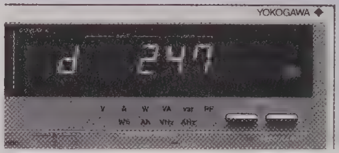
In addition to its self-contained current input ranges, external shunts can be used to extend the current input range. In this way, an input exceeding 5 A can be measured by providing a shunt. Shunt input ranges of 50 mV, 100 mV and 200 mV are provided.

### Various processing functions

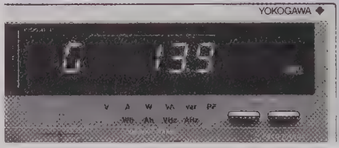
The 2532 first measures active power (**W**), rms voltage (**Vrms**), rms values calculated from mean values of rectified waveforms (**Vmean**), and rms current (**Arms**), then, using these values, it can calculate apparent power (**VA**), reactive power (**var**), power factor (**PF**) and phase angle (**deg**). Watt-hours, ampere-hours and frequency can also be measured.

### Phase lead/lag indication function

**Indication of lead angle ( d )**



**Indication of lag angle ( G )**



An indication of Leading or Lagging phase angle is displayed with phase angle* (**deg**) and power factor (**PF**). When current is ahead of voltage, the phase angle is leading and the load is capacitive. When current is behind voltage, the phase angle is lagging and the load is inductive. These conditions can easily be seen with the 2532.

* Phase angle calculation formula:
$\varphi = \cos^{-1} (W/(V \cdot A))$

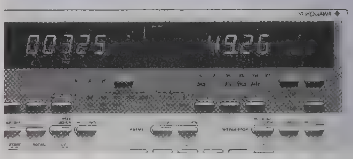
### GPIB or RS-232-C interface provided as standard

The 2532 is provided with either a GPIB or RS-232-C interface as standard (specify when ordering). Through these interfaces, all front-panel keys except for the power switch can be operated from the controller. A total of 4 types of data including the value shown in DISPLAY C as well as the three measured values of active power, voltage and current can be output simultaneously. When integration is performed, the elapsed time and integrated values of watts and current are output simultaneously.

### Easy-to-read simultaneous display of three values

The 2532 is provided with three data displays so that three values — measured and processed values — can be displayed at the same time. Red LEDs and large numerals are used to achieve excellent readability.

### Integrating function (Wh, Ah)



With this, the active power and current can be integrated. Either of two integrating modes can be selected; in the standard integrating mode, integration is performed after a preset integrating time has been reached while in the manual integrating mode, integration is performed for the time specified by pressing the integrator START/STOP button.

### Scaling function

The 2532 allows the PT (Potential Transformer) ratio, CT (Current Transformer) ratio and power scaling factor to be preset. With this function, even when using external PTs and CTs, high power values can be read directly because they are converted to primary measured values before being displayed.

### Filter: Power measurement only of fundamental waveform

This is useful when only the fundamental waveform is to be measured without carrier components, when performing power measurements of an inverter motor, etc.

### Averaging function

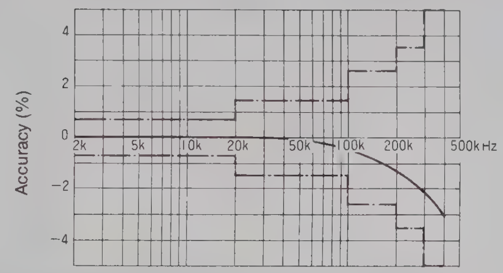
When a power supply or load is unstable, the display of a wattmeter may change continuously, making it difficult to read. In this case, if the exponential averaging operation is performed using the 2532's averaging function, the displayed value becomes stable and can be read easily.

# CHARACTERISTICS ..... that make highly accurate power measurement possible

The characteristics shown on this page are based on data obtained in evaluation testing. For the guaranteed accuracy, refer to the specifications. (Shown by broken lines in the graphs.)

## Power measurement frequency characteristics (W, cos $\varphi = 1$)

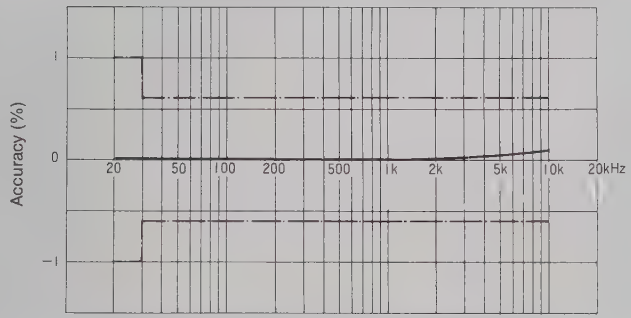
- Voltage range : 100 V
- Current range : 1 A
- Frequency range : High
- Display update cycle : 1.6 s



[Power measuring accuracy vs. frequency characteristics (cos $\varphi = 1$)]

## Zero power factor characteristics (W, cos $\varphi = 0$)

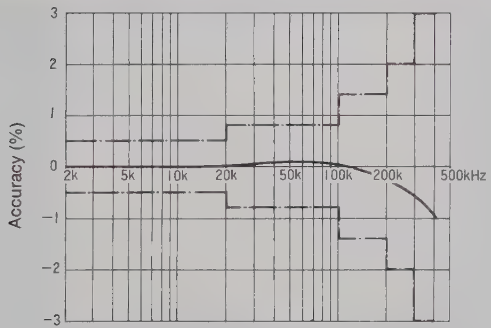
- Voltage range : 100 V
- Current range : 1 A
- Frequency range : Low
- Display update cycle : 1.6 s



[Zero power factor characteristics (W, cos $\varphi = 0$)]

## Voltage frequency characteristics (V)

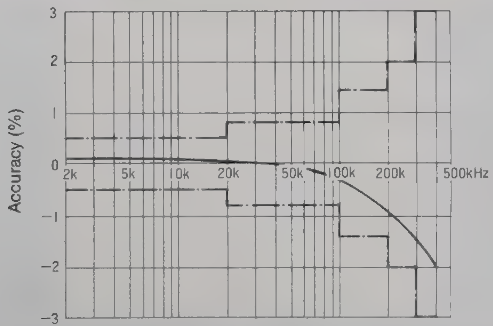
- Voltage range : 100 V
- Frequency range : High
- Display update cycle : 1.6 s



[Voltage accuracy vs. frequency characteristics]

## Current frequency characteristics (A)

- Current range : 1 A
- Frequency range : High
- Display update cycle : 1.6 s



[Current measuring accuracy vs. frequency characteristics]

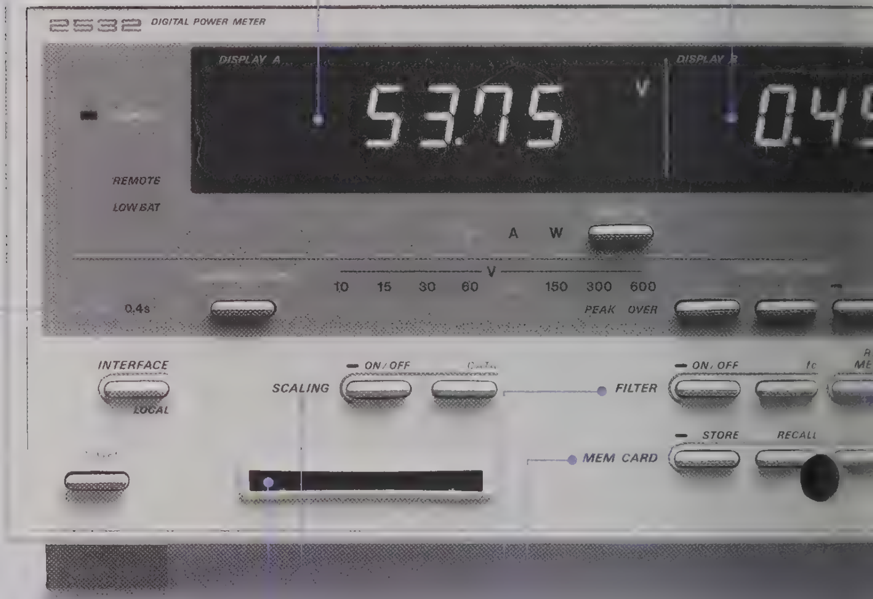
# Front panel

### DISPLAY A

Voltage, current or active power can be displayed.

### DISPLAY B

Voltage, current or active power can be displayed. When using the integration function, the elapsed time can be displayed.



### [illegible]

The update cycle of the display can be switched between 0.4 s and 1.6 s to be suitable for the input signal

### IC memory card slot

With an optional IC memory card, data and panel settings can be stored in memory. When data is recorded on an IC card, the card can be inserted in a YOKOGAWA **LR** or **HR** series recorder which will then plot the data to show trends, etc. A total of 4 items — voltage, current, active power and one of values which can be shown in DISPLAY C — can be stored on a memory card in every write cycle.

| Memory card capacity | Model | Maximum number of data values stored |
|---|---|---|
| 8K bytes | 378901 | 200 data values (when integrating, 360 data values) |
| 16K bytes | 378902 | 500 data values (when integrating, 900 data values) |
| 64K bytes | 378903 | 2000 data values (when integrating, 3800 data values) |

### Store/recall keys

These allow measured data to be stored in or recalled from an IC memory card.

### Filter keys

These switch the filter function ON and OFF and set the cutoff frequency.

### Scaling keys

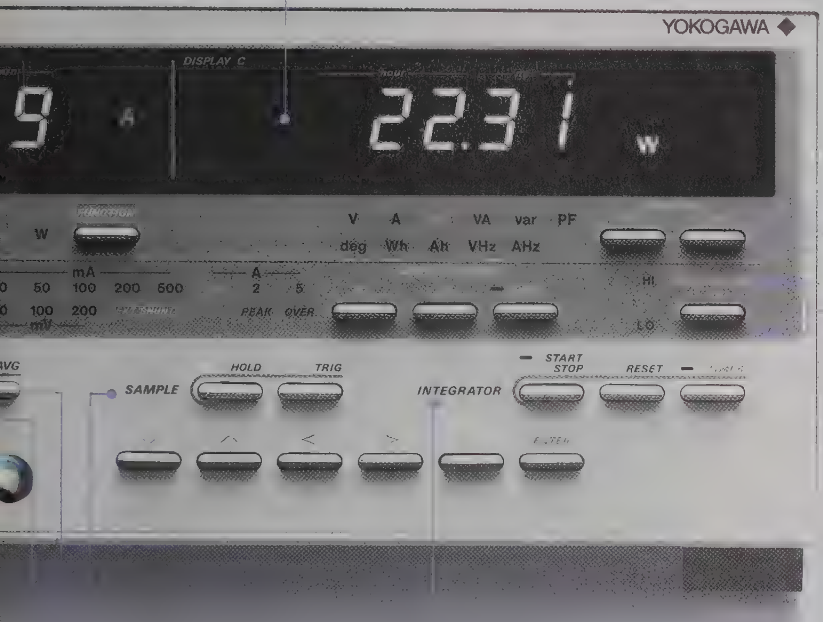
These switch the scaling function ON and OFF and set scaling factors (PT ratio, CT ratio, etc.).

## DISPLAY C

Voltage, current, active power, reactive power, apparent power, power factor, phase angle or frequency can be displayed. When using the integration function, the integrated active power or integrated current value (Wh or Ah) can be displayed.

## Function keys

These are used to select the function of each of the three displays.



## Range keys

These are used to select the ranges of input voltage (VOLTAGE), input current (CURRENT RANGE) and frequency (FREQ RANGE).

## Sample hold/trigger keys

Pressing the HOLD key holds the measured value. When the TRIG key is pressed or an external trigger signal is input, the measured value is updated.

## Integrator keys

When performing integration to obtain Wh and Ah, these are used to specify the manual start and stop times and to set the timer, etc.

## Averaging key

This is used to set the averaging function which makes the indication stable so that the measured value can be read more easily.

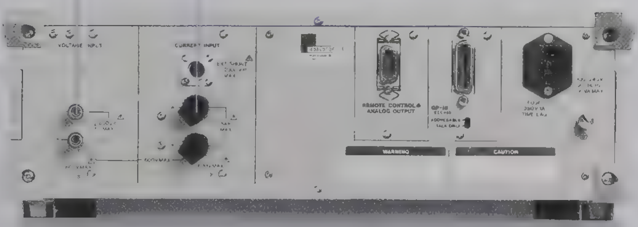
## RMS/MEAN key

Pressing this alternates between the RMS (true rms calibrated value) and MEAN (rms value calculated from mean value of rectified waveform*) displays of the input voltage. Setting to MEAN is effective when measuring an inverter and for transformer core loss tests.

* Assuming that the input waveform is sinusoidal.

■ Voltage input terminals

■ Current input terminals



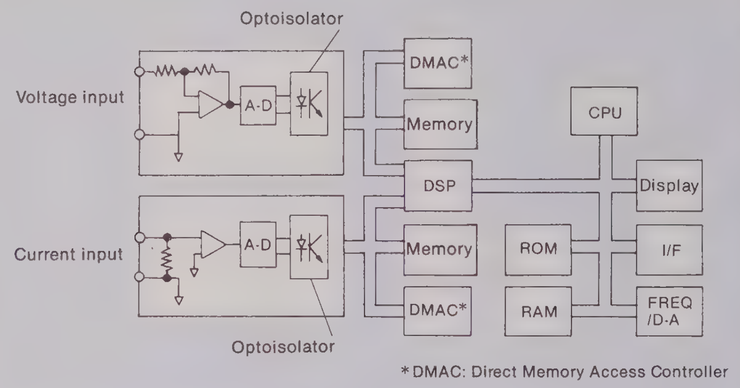
**[Rear panel]**

# TECHNOLOGIES ..... originally developed by YOKOGAWA, for high-accuracy measurement over a wide range of frequencies

## Digital design approach

The wide frequency range — DC, 20 Hz to 400 kHz — and high measuring accuracy of the 2532 have been achieved through state-of-the-art digital measuring circuits. The voltage input circuit contains a potential divider and scaling op-amp. The current input circuit uses a precision high frequency shunt and scaling op-amp. Both voltage and current signals are digitized by separate 12-bit 1 MS/sec A-D converters. The outputs from the A-D converters are isolated by optoisolators before being supplied to the DSP (digital signal processor) board.

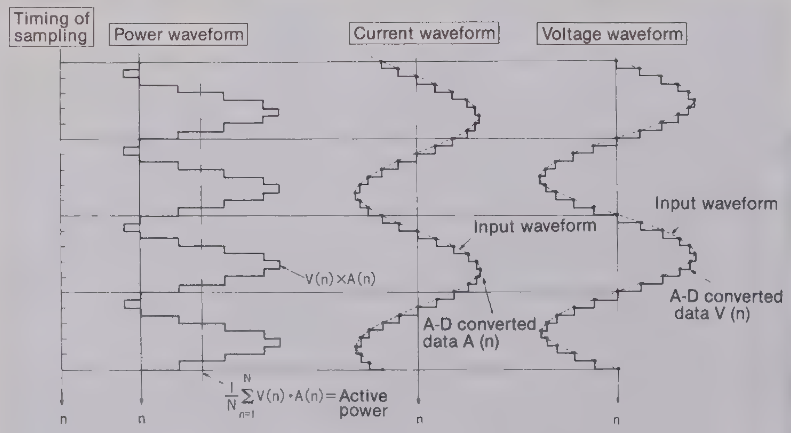
On the DSP board, the digital output signals from the A-D converters are stored in memory temporarily or sent to the DSP directly, according to the setting of the frequency range. The DSP performs the rms voltage and current, rms values calculated from mean values of rectified waveforms and active power calculations, and the results are sent to the CPU. In the CPU, the reactive power, apparent power, power factor, etc. are calculated, and displayed.



[2532 block diagram]

## Wide bandwidth

The 2532 does not use PTs (Potential Transformers) and CTs (Current Transformers) which could be obstacles to achieving a wider bandwidth while a potential divider using resistors is used for voltage division (attenuation) and a shunt resistor is used for current detection. In this way, the 2532 can be used with a wide range of input frequencies, from DC to high frequencies. To acquire waveforms with this wide frequency range and to process waveform data, it uses a 12-bit A-D converter with a 1-MHz sampling rate and a DSP. With these, the 2532 can be used for measurements over a wide range of frequencies, DC and from 20 Hz to 400 kHz.



[Digital signal processing method]

## Digital signal processing

The 2532 uses advanced digital signal processing techniques to achieve high-accuracy measurement over a wide range of frequencies. The instantaneous values of voltage and current are digitized simultaneously. These values are then multiplied to obtain the mean value for a fixed time, so that the active power can be calculated. Independent 12-bit A-D converters with a sampling rate of 1 MHz are used in both the voltage circuit and current circuit. Multiplication and calculation of the mean value are then performed by the digital signal processor, DSP.

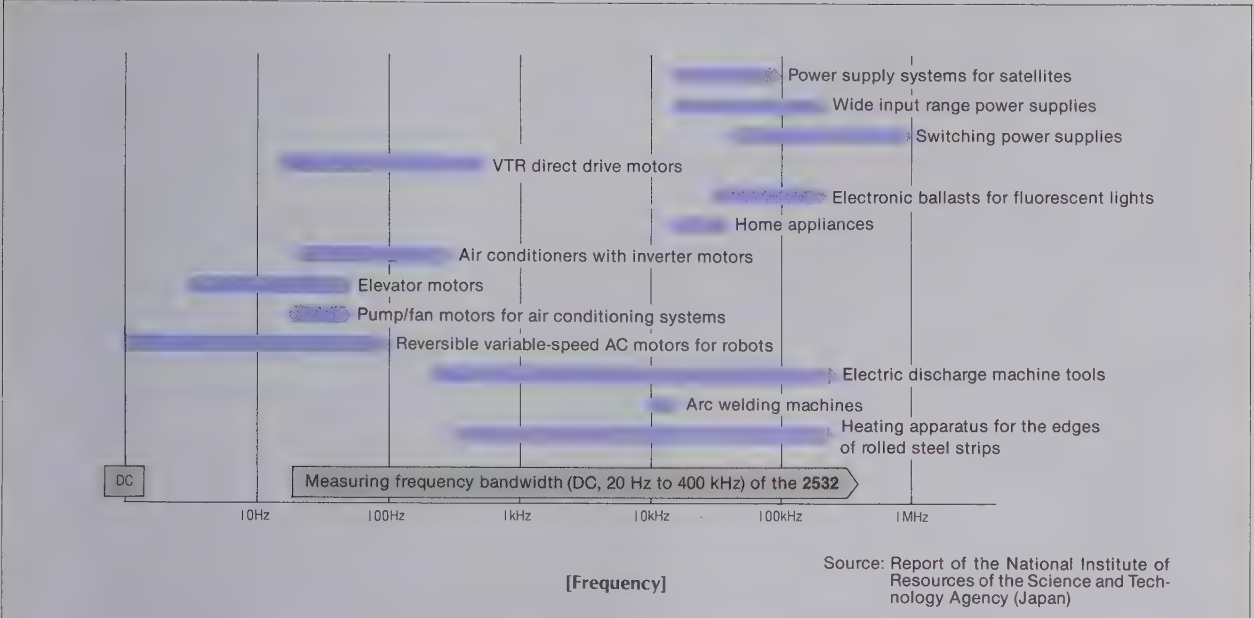
The rms value is obtained by squaring the output from the A-D converters to obtain the mean value for a fixed period of time, then extracting the square root of this value. Reactive power, apparent power, power factor, Wh, Ah, etc. can be performed by processing the V, A and W values.

## Isolation

Isolation gives the 2532 a high withstand voltage and excellent resistance to noise. For safety when measuring power with a large current and high voltage, voltage and current terminals, voltage or current terminal and the case are completely isolated. Isolation is further assured by the high-speed optoisolators used to transmit A-D converted data with a 1-MHz sampling rate to the DSP.

# APPLICATIONS ..... suitable for power measurement in many fields

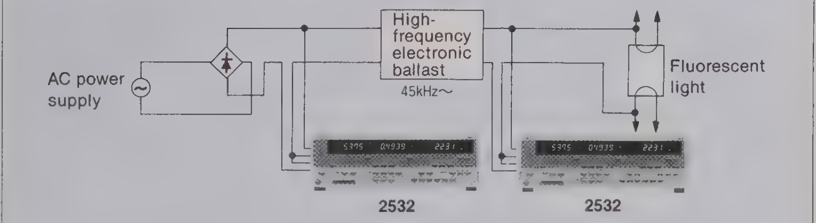
## ■ Power measurement applications



Source: Report of the National Institute of Resources of the Science and Technology Agency (Japan)

## ■ Measuring the power loss and power consumption of a fluorescent light system

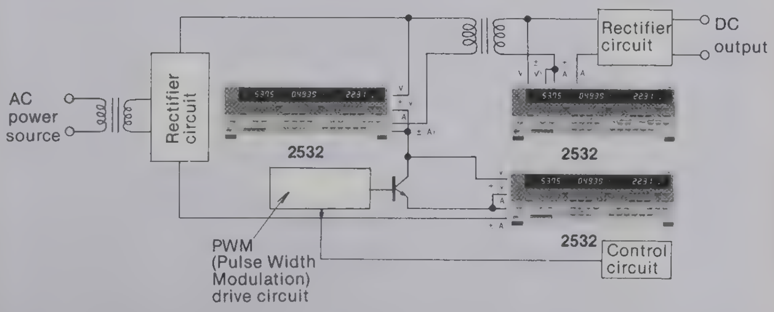
The power loss and power consumption of a fluorescent light system using high frequency electronic ballasts can be easily and accurately measured with the 2532 digital power meter.



[Measuring the power loss and power consumption of a fluorescent light]

## ■ Measuring the efficiency of components of a switching power supply

An application which demonstrates the outstanding abilities of the 2532 is the measurement of the efficiency of elements of a switching power supply such as coils and transistors which are subject to high levels of high-frequency noise.



[Measuring the efficiency of components for a switching power supply]

# Specifications

## Input section

| Items / Inputs | Voltage | Current |
|---|---|---|
| **Input circuit system** | Floating input | |
| | Potential divider using resistors | Shunt input |
| **Rated value (range)** | 10/15/30/60/100/150/ 300/600 V | 20/50/100/200/500 mA<br>1/2/5 A (input current)<br>50/100/200 mV (external shunt input ranges) |
| **Input impedance** | Approx. 1 MΩ (all ranges) (Approx. 15 pF in parallel) | 20/50/100 mA: Approx. 2 Ω<br>200/500 mA/1 A: Approx. 0.2 Ω<br>2/5 A: Approx. 0.05 Ω<br>(Approx. 0.4 μH in series)<br>External shunt input resistance: Approx. 1 kΩ |
| | With capacity of approx. 100 pF between the input terminals (±) and case | |
| **Frequency range** | DC, 20 Hz to 400 kHz | |
| **Instantaneous maximum allowable input (for 1 s)** | The peak is 3.5 times the range or 1,400 V (whichever is less) | The peak is 7 times the range or the rms value is 3 times the range (whichever is less) (with 10 Arms max.)<br>External shunt input range: Peak voltage is 5 V or less |
| **Continuous maximum allowable input (at 50/60 Hz)** | The peak is 1,000 V or the rms value is twice the range (whichever is less) | The peak is 5 times the range or the rms value is twice the range (whichever is less)<br>External shunt input range: Peak voltage is 1 V or less |
| **Continuous maximum common mode voltage 50/60 Hz** | 600 Vrms | 600 Vrms |
| **Effect of common mode voltage (at 50/60 Hz)** | Less than ±0.025% of range (when input terminals are shorted, 600 V is applied between input and case) | Less than ±0.025% of range (when 600 V is applied between input (±) and case with input terminals open) |
| **Input terminals** | Binding posts | Large binding posts<br>External shunt input: 4-pin round shape connector |
| **Filter** | OFF, cutoff frequency (fc) 250/500/1000/2000 Hz or range specified (250 to 2000 Hz) | |
| **Accuracy** (with filter ON) | V, A: 2% of range added to the measuring accuracy at fc/10<br>W (cos $\varphi = 1$): 4% of range added to the measuring accuracy at fc/10 | |
| **Overrange detection** | Approx. 3.5 times the range (alarm lamp lights when detected) | |
| **A-D conversion section** | Simultaneous sampling of voltage and current inputs<br>Resolution: 12 bits<br>Maximum conversion rate: 1 MS/s | |
| **Range switching** | With manual, automatic and external controls (GPIB or RS-232-C), V and A can be switched independently | |
| **Auto range switching** | Range up: When the peak value exceeds 350% of the rated range or the measured value exceeds 110% of the rated range<br>Range down: When the measured value becomes less than 30% of the rated range | |

## Display functions

**Display type** : LED (light-emitting diodes)
**Displayed values** : three measured values can be displayed simultaneously

| Display | Display contents | Maximum reading |
|---|---|---|
| A | V, A, W | V, A: 14000<br>(W depends on max. reading of V, A)<br>Wh, Ah: 999999<br>Hz: 19999 |
| B | V, A, W, elapsed time of active power and current integration | |
| C | V, A, W, VA, var, PF, deg, Wh, Ah (Hz ... optional) | |

**Unit display** : m, k, M, V, A, W, VA, var, Hz, h, deg
**Display update cycle (SAMPLE RATE)**: 0.4 s or 1.6 s (selectable)
**Response time** : With display update cycle of 0.4 s, approx. 0.8 s
With display update cycle of 1.6 s, approx. 3.2 s (For reading within specified accuracy of final value against an input variation from 10 to 100% or 100 to 10% of the range)

### • Display scaling functions

**No. of effective digits**: Automatically selected according to the no. of effective digits of the voltage or current range
**Setting range** : 0.0001 to 10000
**Set value** : "DISPLAY A": PT ratio
"DISPLAY B": CT ratio
"DISPLAY C": Power scaling factor

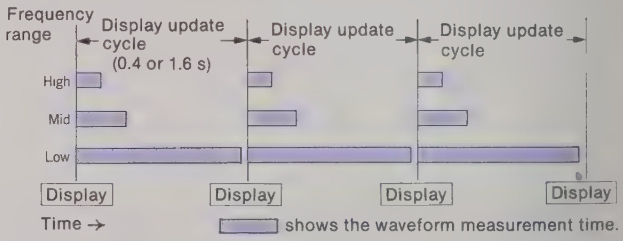
### • Display averaging function

**Method** : Exponential averaging method
**Attenuation coefficient**: 8 (fixed)

## Measurement functions

| Items / Inputs | | Voltage and current | Power | Remarks |
|---|---|---|---|---|
| **System** | | Digital multiplication system | | |
| **Crest factor** | | With rated input: 3 | | |
| **Frequency range** | | High: DC, 2 to 400 kHz<br>Mid : DC, 200Hz to 80 kHz<br>Low : DC, 20 Hz to 10 kHz | | Display update cycle: 1.6 s |
| **Waveform measuring time** (refer to note) | | Display update cycle (SAMPLE RATE) of 0.4 s,<br>High: Approx. 12 ms<br>Mid : Approx. 50 ms<br>Low : Approx. 0.4 s<br>Display update cycle (SAMPLE RATE) of 1.6 s,<br>High: Approx. 48 ms<br>Mid : Approx. 200 ms<br>Low : Approx. 1.6 s | | Under the following conditions;<br>Temperature: 23±3°C<br>Humidity: 45 to 75% R.H.<br>Power supply voltage: 100 V±1%<br>Input waveform: Sine wave<br>Input common mode voltage: 0 V<br>After calibration: Within 90 days<br>Scaling: OFF<br>Input: 10 to 110% of the range<br>Display update cycle: 1.6 s<br>Filter: OFF<br>Power factor (cos φ) = 1 when power is measured.<br>These accuracies are guaranteed by YOKOGAWA calibration system.<br>The guaranteed accuracy is within the selected frequency range. |
| **Accuracy** (display) | DC | ±(0.2% of rdg + 0.2% of range) | ±(0.3% of rdg + 0.2% of range) | |
| | 20 to 30 Hz | ±(1.0% of rdg + 0.4% of range) | ±(2.0% of rdg + 0.6% of range) | |
| | 30 to 45 Hz | ±(0.3% of rdg + 0.2% of range) | ±(0.5% of rdg + 0.2% of range) | |
| | 45 to 66 Hz | ±(0.2% of rdg + 0.2% of range) | ±(0.3% of rdg + 0.2% of range) | |
| | 66 Hz to 20 kHz | ±(0.3% of rdg + 0.2% of range) | ±(0.5% of rdg + 0.2% of range) | |
| | 20 to 100 kHz | ±(0.6% of rdg + 0.2% of range) | ±(1.0% of rdg + 0.4% of range) | |
| | 100 to 200 kHz | ±(1.0% of rdg + 0.4% of range) | ±(2.0% of rdg + 0.6% of range) | |
| | 200 to 300 kHz | ±2% of range | ±3.5% of range | |
| | 300 to 400 kHz | ±3% of range | ±5.0% of range | |
| **Effect of power factor** | 20 Hz to 20 kHz | — | ±0.4% of range | With cos $\varphi = 0$ |
| **Temperature coefficient** | | ±0.05% of range/°C | | 5 to 20, 26 to 40°C |

**Note)** With the 2532, only parts of the voltage and current waveforms in the display update cycle may be used for measurement. The parts of the waveform used for measurement differ depending on the display update cycle and selected frequency range. This is defined as the "waveform measurement time".



▭ shows the waveform measurement time.

## Processing functions

| | Apparent power (VA) | Reactive power (var) | Power factor (PF) | Phase angle (deg) |
|---|---|---|---|---|
| **Processing formula** | V × A | $\sqrt{(V \times A)^2 - W^2}$ | $\frac{W}{V \times A}$ | $\cos^{-1}(\frac{W}{V \times A})$ |
| **Processing range** | V, A ranges (rated values) | V, A ranges (rated values) var ≧ 0 | −1 to 0 to 1 | 0 to 180 |
| **Processing accuracy** | ±0.05% of the rated value (VA) | ±0.05% of the rated value (var) | ±0.001 | ±0.1 deg for the value operated from PF |

**Note 1.** Apparent power (VA), reactive power (var) and power factor (PF) are obtained by digital processing of the voltage, current and active power. When a distorted waveform is input, the measured value may be different from that measured by a measuring instrument using a different measuring principle.

**2.** The phase lead/lag display is provided with V and A inputs 30% or more of the rated value in 20 Hz to 20 kHz. (When it is less than 30%, they are not displayed.) The detection accuracy of phase lead and lag is ±5 deg.

## ■ Integration functions (Wh, Ah)

**Maximum display** : ±999999 (6 digits)
**Maximum integration time**: 999 h
**Measurement frequency range**: DC, 20 Hz to 16 kHz
**Display** : Wh or Ah is shown in "DISPLAY C".
**Timer** : Integration can be stopped automatically by setting the timer.
Set value 000 h: 00 min to 100 h: 00 min
(With 000 h: 00 min, manual mode is set.)
**Elapsed time** : The elapsed time from the start of the integration is shown in "DISPLAY B".
**Count over** : When the integrated value is too high, the elapsed time is maintained and integration is stopped.
**Accuracy** : ± (measuring accuracy+0.2% of rdg)
**Timer accuracy** : ±0.02 %
**Remote control** : Start, stop and reset can be controlled with external contact signals
**Additional functions** : The display resolution can be set with internal DIP switches.
**DISPLAY A** : No indication

## ■ Communications functions

- **GPIB:** Electric and mechanical specifications;
  Conforms to IEEE standard 488-1978
  Functional specifications;
  SH1, AH1, T6, L4, SR1, RL1, PP0, DC1, DT1, C0
- **RS-232-C:** Transmission system; Start-stop asynchronous mode
  Data transfer rate; 75, 150, 300, 600, 1200, 2400, 4800, 9600 bps

## ■ IC memory card

IC cards with capacities of up to 64K bytes can be used.
**Functions** : Storing and recalling measured data, save and load of panel settings

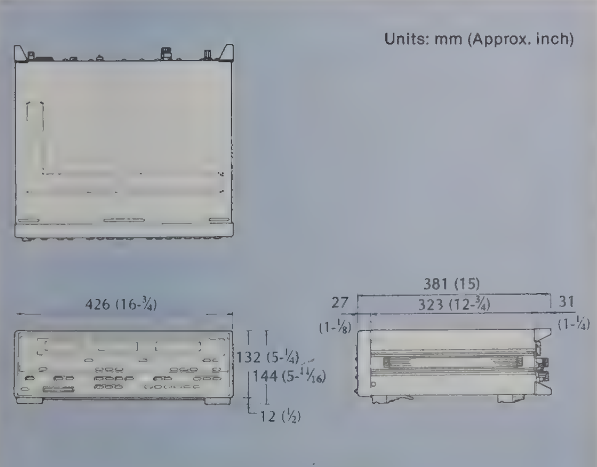
## ■ Frequency measurement (optional specifications)

**Measurement system**: Reciprocal system
**Measurement input** : Voltage or current

| Display update cycle | Measurement frequency range |
|---|---|
| 0.4 s | 20 Hz to 1000 kHz |
| 1.6 s | 2 Hz to 100 kHz |

**Accuracy** : ± (0.1% of rdg+1 digit)
**Minimum input sensitivity**: ±10% of range
**Display range** : 2.000 Hz to 1000.0 kHz (4-1/2 digits)
**Sampling rate** : 0.4 s/1.6 s

## ■ Dimensions



Model 253211 & 253212

## ■ D-A converter output (optional specifications)

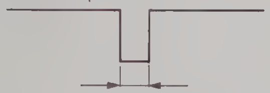
**System** : 16-bit PWM system
**Output voltage** : ±5 V for each rated value
**Accuracy** : ± (measuring accuracy +0.2% of full scale)
**Temperature coefficient** : ±0.05%/°C of full scale
**Output data** : Data shown in "DISPLAY C" (one of V, A, W, VA, var, PF, Wh, Ah, deg and Hz)
**Output update cycle**: Same as display update cycle
**Response time** : Display response + approx. 400 ms (For reading within specified accuracy of final value against an input variation from 10 to 100% or 100 to 10% of the range)

## ■ General specifications

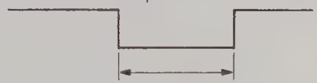
**External control and output:**

| Signal name | Input/ output | Operation | Level |
|---|---|---|---|
| EXT HOLD | Input | Display hold | TTL |
| EXT TRIG | Input | Display update | TTL |
| EXT START | Input | Start of integration | TTL |
| EXT STOP | Input | Stop of integration | TTL |
| EXT RESET | Input | Reset of integration | TTL |
| INTEG BUSY | Output | During integration | TTL |
| 100 Hz | Output | Clock (for timer reference) | TTL |

Control input



INTEG BUSY output



**Operation temperature and humidity range**: 5 to 40°C, 20 to 80% R.H.
**Warming up time** : Approx. 1 hour (until all specifications are satisfied)
**Insulation resistance**: 50 MΩ or more with 500 V DC (between each input terminal and case, each input terminal and output terminal, voltage terminal and current terminal, each input or output terminal or case and power supply)
**Withstand voltage** : 2200 V AC, 50/60 Hz, for 1 minute (between each input terminal and case, each input terminal and output terminal, each input terminal and power supply, voltage terminal and current terminal), 1,500 V AC, 50/60 Hz, for 1 minute (between output terminal or case and power supply)
**Power supply** : 90 to 250 V AC, 48 to 63 Hz
**Power consumption**: Approx. 30 to 75 VA
**Dimensions** : Approx. 132 × 426 × 350 mm (5-1/4" × 16-3/4" × 13-13/16")
**Weight** : Approx. 8 kg (17.6 lbs)
**Accessories** : Power cord × 1, spare fuse × 1 (inside fuse holder), input cable for external shunt × 1, remote control connector × 1, instruction manual × 1

## ■ Model and specification code

| Model | Suffix code | | Description |
|---|---|---|---|
| 253211 | ···················· | ············ | Provided with GPIB |
| 253212 | ···················· | ············ | Provided with RS-232-C |
| Version | –A ············ | ············ | — |
| Power supply voltage | –O | ············ | 90 to 250 V AC |
| Optional feature | | /FRQ | Frequency measurement, D-A output |

## ■ Accessories (optional)

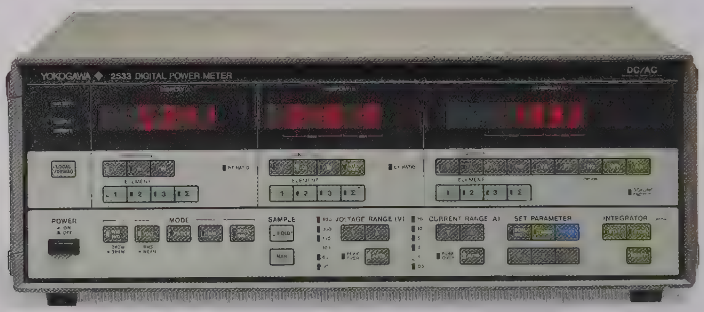
| Model | Model or parts number | Description | Order Q'ty |
|---|---|---|---|
| IC memory card | 378901 | 8K bytes | 1 pc |
| IC memory card | 378902 | 16K bytes | 1 pc |
| IC memory card | 378903 | 64K bytes | 1 pc |
| Dummy card for memory card slot | B9586NG | Dust cover | 2 pcs |
| Kit for rack mounting | 751505 | EIA | 1 unit |
| | 751506 | JIS | 1 unit |

## Related instruments

### 2533 Digital Power Meter

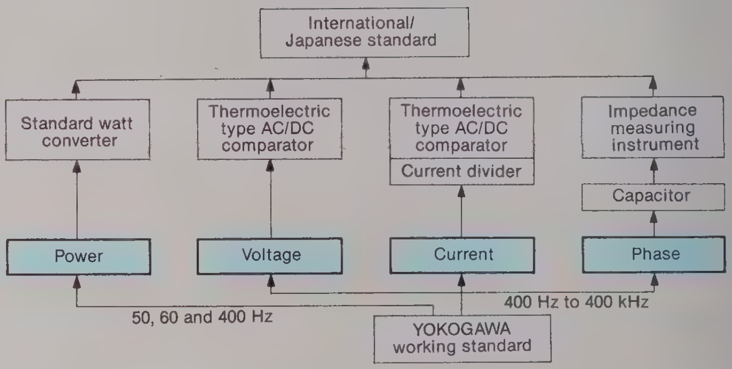
**Wide lineup from DC to 20 kHz, single-phase, 3-phase 3-wire and 3-phase 4-wire**

- **Frequency bandwidth**: DC, 10 Hz to 20 kHz
- **High accuracy**: ±0.1% (45 to 66 Hz)
- Easy-to-read with three value displayed simultaneously
- Comprehensively equipped, with various functions including scaling and averaging, etc.



## Traceability of the 2532 digital power meter

For power measurements at 50 Hz, 60 Hz and 400 Hz, an international/Japanese standard has been established and traceability has been confirmed using the standard watt converter shown in the block diagram.
The 2532 is able to measure at frequencies up to 400 kHz. However, the international and Japanese standards do not specify power measurements at frequencies over 400 Hz. Therefore, YOKOGAWA has established its own calibration system as shown in the diagram.


International/ Japanese standard
Standard watt converter
Thermoelectric type AC/DC comparator
Thermoelectric type AC/DC comparator
Current divider
Impedance measuring instrument
Capacitor
Power
Voltage
Current
Phase
50, 60 and 400 Hz
400 Hz to 400 kHz
YOKOGAWA working standard

YOKOGAWA

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02

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Printed in Japan; May 1991 (A)/(LT/YG)

# 2533 DIGITAL POWER METER

## Three Displays in One ... V, A, W, $\bar{V}$, $\bar{A}$, VA, var, PF

### Single-phase, 3-phase 3-wire, 3-phase 4-wire models with DC, 10 Hz to 20 kHz range

RS-232-C
GPIB

YOKOGAWA

Bulletin 2533-E

# Precision Measurement of Distorted Waveforms with Powerful Computing Capability.

The Model 2533 Digital Power Meter is an outstanding solution to accurate power measurement of distorted waveforms with simple and fast flat-key controls. Model 2533 includes six basic models for single-phase, 3-phase 3-wire, and 3-phase 4-wire circuit with or without DC measurement. All models incorporate easy-to-use, versatile computing functions, and provide direct digital reading of voltage, current, power in each phase or total power, apparent power, reactive power, power factor, and more.

## Convenient Features

- **Simultaneous display of V, A & W (or VA, var, PF)**
- **0.1% accuracy**
- **Wide frequency range — DC, 10Hz to 20kHz**

  Suitable for accurate power measurement of distorted waveforms, half-wave, full-wave and inverter waveforms.
- **Versatile computing functions**

  Powerful computing functions include $\overline{V}$ (mean value of line or phase voltage), $\overline{A}$ (mean value of phase current), VA (apparent power), var (reactive power), and PF (power factor).
- **Scaling — Direct reading of V, A and W even when used with external CT and PT**
- **Simplified programming and operation via membrane-sealed keyboard**
- **Analog output of up to 12 signals (standard)**
- **GPIB or RS-232-C programmable (optional)**
- **Integration (Wh, Ah) and frequency measurement (optional)**

## Examples of 2533 Applications

The high-precision and wide frequency band analyzing function makes Model 2533 useful for diverse fields of applications including measurements, tests and inspections in R & D and on production lines.

- **Calibration of test and measuring instruments**
- **Audio, acoustic and household appliances**

  Air-conditioners, TV sets, VTR's, refrigerators, cleaners, power amplifiers, speakers.
- **Electric and machinery**

  Motors, inverters, transformers, industrial robots.
- **Power supplies**

  Switching power supplies, power inverters, cycloconverters, rectifiers.
- **Lighting fixtures**

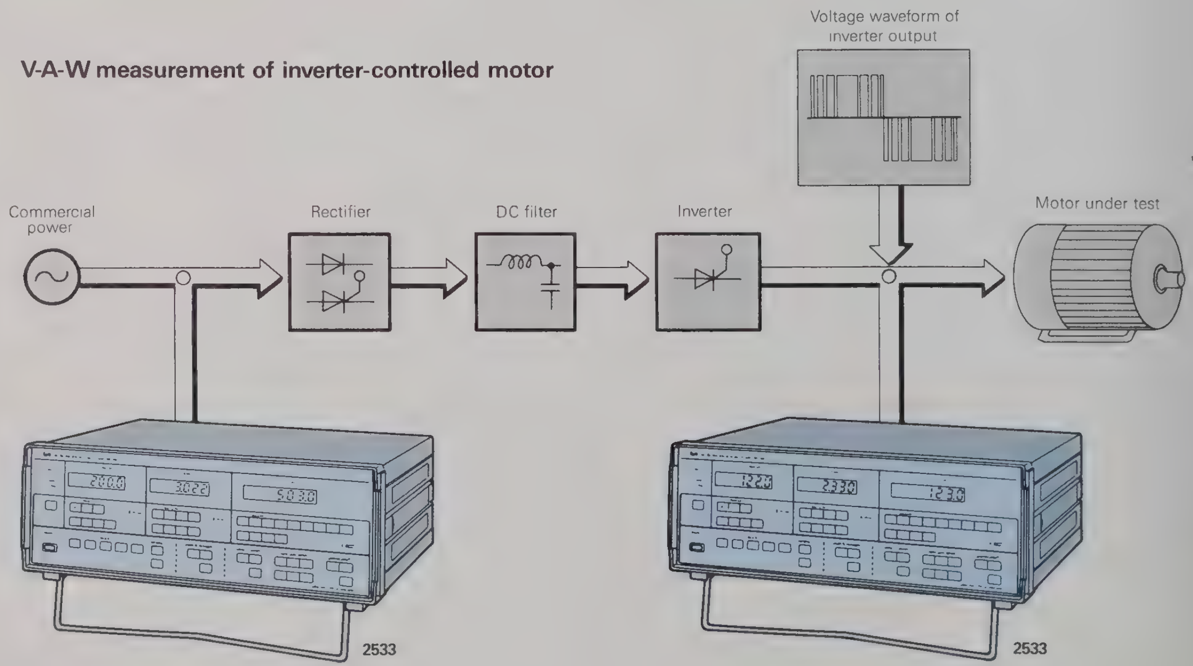
  Fluorescent lamps, incandescent lamps, mercury lamps, sodium-vapor lamps.
- **Office equipment**

  Facsimile equipment, electronic copiers, electronic typewriters, printers, office computers.
- **Metals, iron and steel**

  Metal rolling machines, Epstein, core loss tests.
- **Welding**

  Spot welding, arc-spot welding.

**V-A-W measurement of inverter-controlled motor**



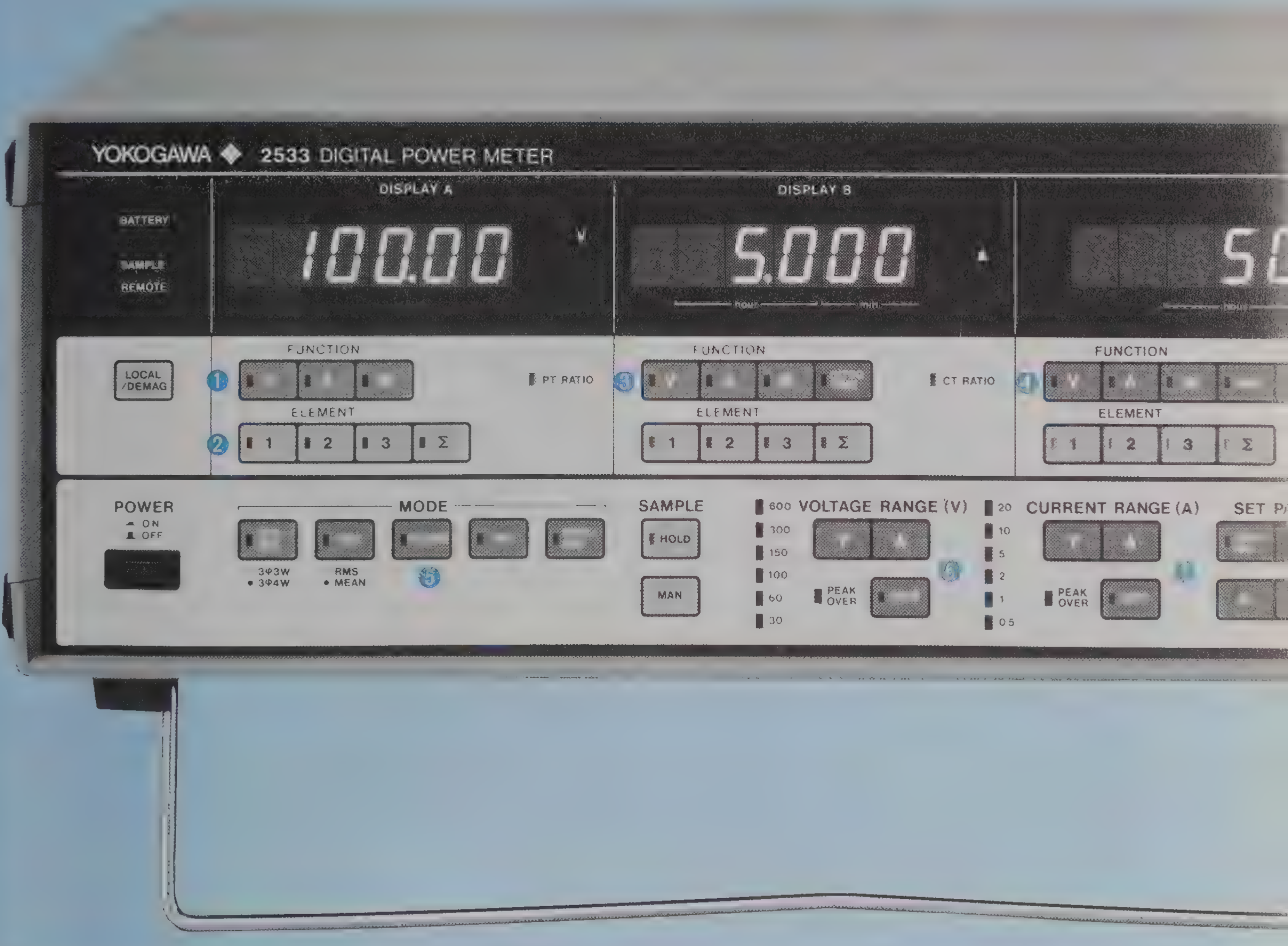
**① FUNCTION keys**
Selectable for V, A or W measurement.

**② ELEMENT keys**
Used to select each phase (or line) in 3-phase 3-wire or 4-wire circuit. Σ key provides mean value (V, A), or the sum of each power (W). (ELEMENT keys are not provided in the single-phase model)

**③ FUNCTION keys**
In addition to V, A and W, integration time can also be displayed as an option.

**④ FUNCTION keys**
In addition to V, A and W, var, VA, PF (Hz, Wh, Ah... optional) can also be selected.

**⑤ MODE keys**
WIRING: For 3-phase 4-wire circuit. (WIRING key is not provided in the single-phase model)
VOLT: Selectable for RMS (true rms measurement & display), or MEAN (mean value rectification measurement & rms value



# Specifications

## GENERAL SPECIFICATIONS

**Display:** LED display.

**Display Combination:**

| Display mode | Max. reading | Display configuration |
|---|---|---|
| A | ±99999 | V, A, W, (1, 2, 3, Σ)* |
| B | ±99999 | V, A, W, (1, 2, 3, Σ)*<br>integration time ... optional |
| C | ±99999<br>(±999999 ... Wh, Ah) | V, A, W, VA, var, PF (1, 2, 3, Σ)*<br>(Hz, Wh, Ah... optional) |

*Notes: 1 only ... single phase model.
1, 3, Σ ... 3-phase 3-wire model.

**Engineering Units:** m, k, M, V, A, W, VA, var, Hz, h (hour).

**Function Selection:** Manual for Display A, B, C each by front-panel keys (or remote via optional GPIB or RS-232-C interface).

**Sample Rate:** Approx. 2.5 times/s.

**Ranging:** Automatic or manual (or remote via optional GPIB or RS-232-C interface).

**Effective Measuring Range:** 10 to 110% of rated value (range).

**Response Time:** Approx. 0.4 s. (at filter OFF, for analog output within ±0.2% accuracy against an input variation from 30% to 100% of range, or from 100% to 30% of range).

**Data Outputs:** Analog outputs...up to 3 signals (single-phase model), up to 9 signals (3-phase 3-wire model), up to 12 signals (3-phase 4-wire model).

## Optional Features

### ■ GPIB Interface (/GP-IB)

**Functional, Electrical and Mechanical Specifications:** Meets IEEE Standard 488-1978 "Digital Interface for Programmable Instrumentation."

**Interface Function and Identification:** SHI, AHI, T5, L4, SR1, RL1, PP0, DC1, DT1, C0 (Talker & Listener, Talk only).

### ■ RS-232-C Interface (/RS232C)

**Functional Specifications:** Hardware/software handshaking, synchronous (data transfer rates... 75, 150, 300, 600, 1,200, 2,400, 4,800, 9,600 bits/s).

### ■ Frequency Measurement (/FRQ)

**Operating Principle:** Reciprocal counting method.

**Frequency Range:** 10Hz to 200kHz (filter OFF), 2 to 500Hz (filter ON).

**Accuracy:** ±(0.1% + 1 digit).

**Maximum Sensitivity:** ±10% of full scale.

**Display Range:** 2.000Hz to 240.0kHz (4 digits).

**Sample Time** 400ms.

**Measuring Input:** V1 or A1.

### ■ Integrator (/INTEG)

**Maximum Reading:** ±999999 (full 6 digits).

**Integration Time:** Up to 999h.

**Integration Display:** Ah or Wh (on Display C).

**Timer:** Automatically stops integration by presetting timer (setting range... 000h: 01min to 999h: 00min, timer OFF at 000h: 00min), timer accuracy... ±0.02%.

**Elapsed Time Display:** 00h: 01min to 999h 59min after integration start (on Display B).

**Accuracy:** ±(2533 accuracy + 0.02% of rdg + 1 digit).

**Temperature Coefficient:** ±0.025% of range/°C (±0.014% of range/°F).

**Remote Controls:** Integrator START/STOP/RESET by external contact signal.

**D-A Converter Function**

**Operating Principle:** Pulse width modulation method (16 bits).

**Output:** Wh, Ah, var, VA, PF or Hz (display data).

**Output Level:** −7.5 to 7.5V, 5V/full scale, (accuracy ... 2533 accuracy + 0.1% of full scale).

**Sample Time:** 400ms.

**Temperature Coefficient:** ±0.02%/°C (±0.01%/°F).

### Available Models

| Model | | Suffix Codes | | Description |
|---|---|---|---|---|
| **2533** | | | | Digital power meter |
| | **11** | | | Single-phase (AC) |
| | **12** | | | 3-phase 3-wire (AC) |
| | **13** | | | 3-phase 4-wire (AC) |
| | **21** | | | Single phase (DC/AC) |
| | **22** | | | 3-phase 3-wire (DC/AC) |
| | **23** | | | 3-phase 4-wire (DC/AC) |
| Power Requirements | | **-1** | | 100V AC (50 & 60Hz) |
| | | **-3** | | 115V AC (50 & 60Hz) |
| | | **-5** | | 200V AC (50 & 60Hz) |
| | | **-7** | | 230V AC (50 & 60Hz) |
| Power Cord | | | **/B** | JIS standard |
| | | | **/D** | UL standard |
| | | | **/F** | VDE standard |
| | | | **/G** | SAA standard |
| | | | **/J** | BS standard |

### Optional Features

| Option Code | Name |
|---|---|
| **/GP-IB** | *GPIB interface |
| **/RS232C** | *RS-232-C interface |
| **/FRQ** | Frequency measurement |
| **/INTEG** | Integrator |

*Note: Both GPIB and RS-232-C are not compatible with a single instrument.

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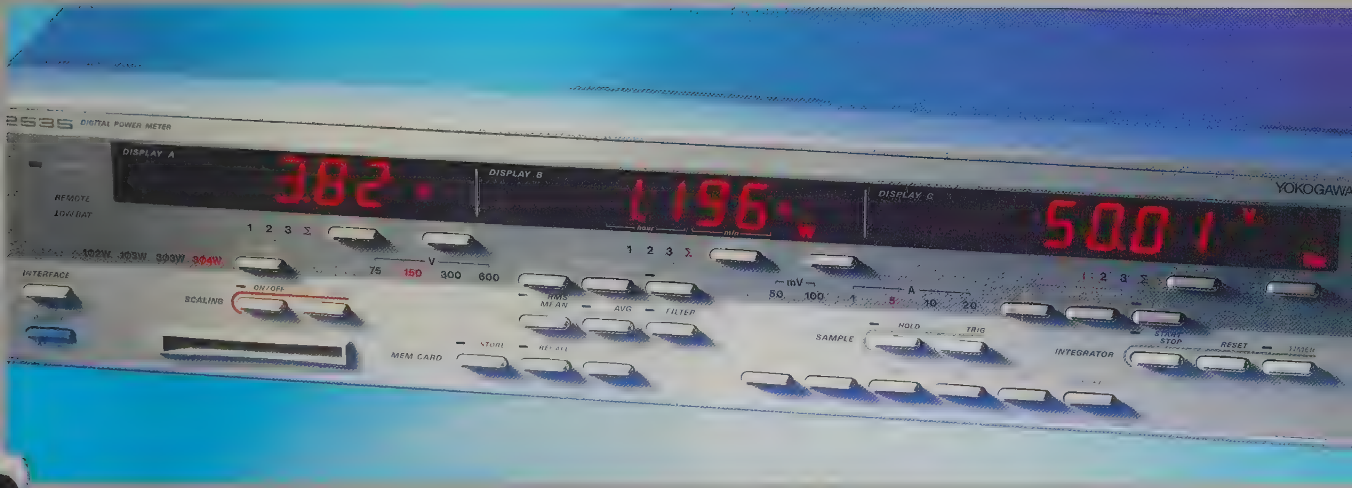
Printed in Japan; Sept. 1991(C)/(D/YG)

# DIGITAL POWER METERS

YOKOGAWA

# 2534
# 2535



*Wide bandwidth: DC, and 10 Hz to 20 kHz*
*High accuracy, 0.5%*
*Extensive computing capabilities (PF, deg, Wh, etc.)*

****REPRESENTED BY:*****
NORTHERN TECHNICAL SALES
PO BOX 614
LIVERPOOL, N.Y. 13088
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Bulletin 2534-E

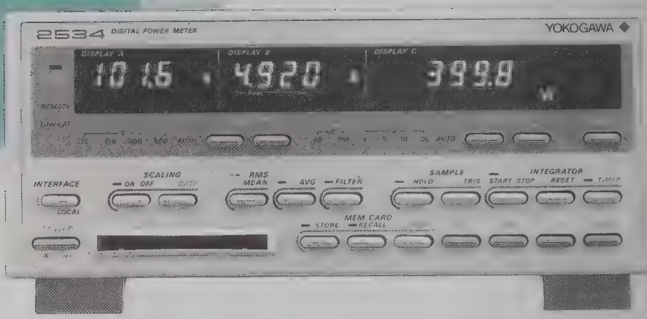
# Outstanding high cost-performance rati

## Handling the full spectrum of powe

Recent years have brought a rapid integration of switching power supplies into home and office products such as TV's, fax machines, and personal computers. With power supply current waveforms that contain over the 30th order harmonics and above. These power supplies make it impossible to get accurate power measurements using conventional, bandwidth-limited, portable power meters.
At the same time, interest is also increasing in the use of DC power units and

## 2534

### Single-phase



## Basic Functions

### Wide Bandwidth: DC, 10 Hz to 20 kHz

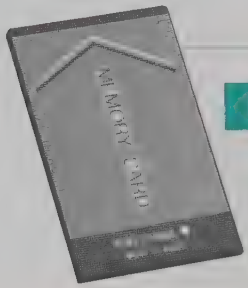
The Models 2534 and 2535 make use of digital sampling techniques to cover the full frequency range from DC, 10 Hz to 20 kHz. Thus you can use these power meters to measure the power consumption of products having highly non-sinusoidal power waveforms — such as TV's and computers with switching power supplies — and to measure the performance of inverter-driven motors.

### High Accuracy: 0.5%

Since these power meters achieve 0.5% accuracy (at 50/60 Hz, as percent of full-scale), they satisfy the requirements for accurate power measurements of general equipment, and can be used for formal product performance testing.

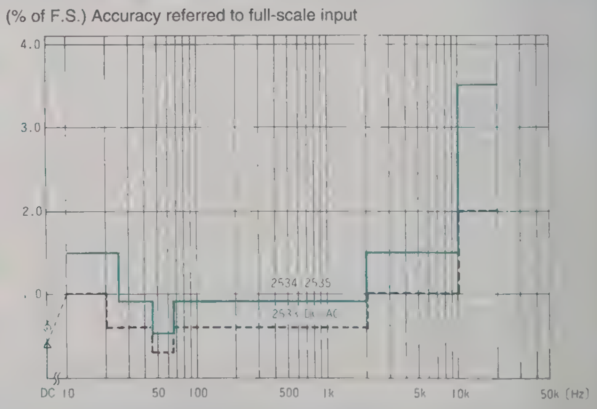
### DC Power Measurement Capability

The high-performance shunt resistors employed in the current input sections of these power meters enable precision measurement of DC current and power. This makes them ideal for evaluation tests of DC power sources and battery-powered equipment.



### IC Memory Cards

IC memory cards provide compact, reliable storage of measured data and panel setups.



Power accuracy vs. frequency (cos$\phi$=1)

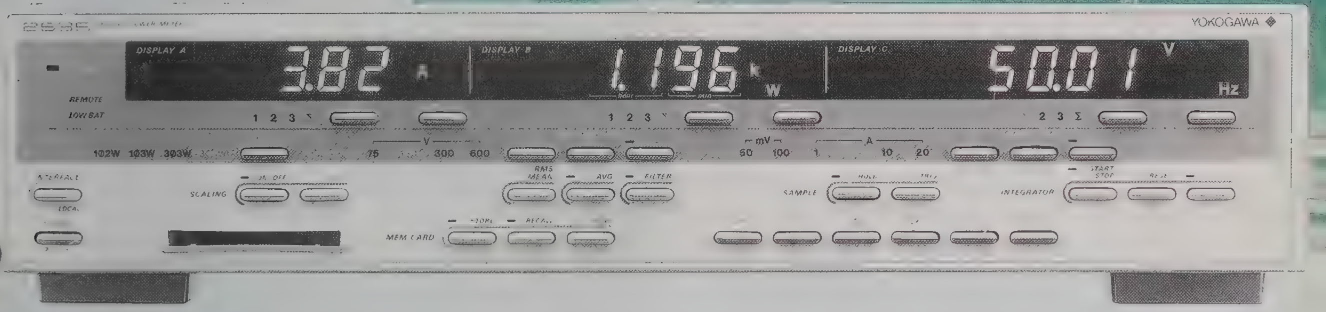
# a compact, lightweight package

## asurements from portable to system applications

batteries for clean energy, as in electric cars. And this demands the ability to measure power at DC and over wide frequency bandwidths required for inverter efficiency measurements.
To answer the needs created by these innovations, Yokogawa is using advanced digital technologies in the two new general-purpose power meters, that are both compact and light in weight.

# 2535

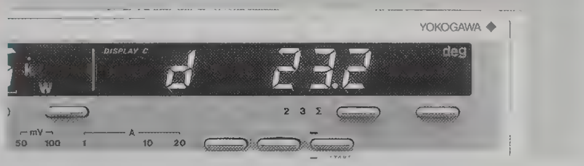
**3-phase 3-wire**
**3-phase 4-wire**



## ■ Extensive Computing Capabilities

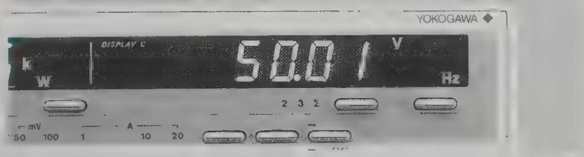
### Phase Angle Display: 0 to ±90deg

The 2534 and 2535 can compute the phase angle of the current with respect to the voltage. Lead is indicated by d and lag is indicated by G. This shows the nature of the load (whether it is inductive or capacitive) at a glance.



### Frequency Measurement: 4 Hz to 22 kHz

The frequency of the voltage or current input (Channel 1 only in the 2535) can be measured at high 0.01 Hz resolution (for inputs up to 100 Hz). With filtering enabled, the power meters can measure the fundamental frequency of an inverter waveform.



### Power Integration Function: Wh

The power integration function enables energy consumption measurement by integrating the active power. The power meters offer two integration modes to meet differing application needs: a standard integration mode in which you can preset the integration time, and a manual mode in which you can start and stop integration whenever you want.

# System-Friendly

## Communications Functions (Optional): GP-IB or RS-232-C

When equipped with a communications function option, the Model 2535 can deliver thirteen types of data at the same time to a host computer or other device. Based on the actual measurements (the six instantaneous values of voltage and current, plus frequency), the meter performs digital computations to generate a total of thirteen values: the V, A, W values for each phase, their $\Sigma$ values, and whatever function is selected at the time for Display C (Hz, PF, etc.).

**The 13 Data Types Measured Simultaneously**

$V_1$, $V_2$, $V_3$, $A_1$, $A_2$, $A_3$, $W_1$, $W_2$, $W_3$, $\Sigma V$, $\Sigma A$, $\Sigma W$, and Wh (or any one of: VA, var, PF, Hz, deg)

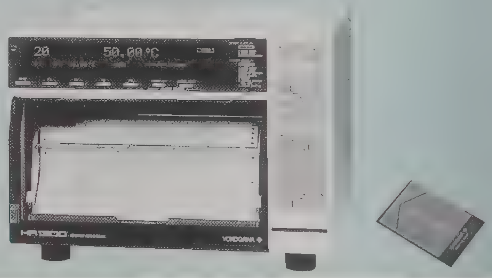
## D-A Output

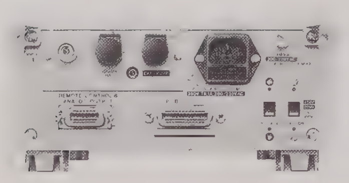
The D-A converter gives a ±5 V full-scale DC output proportional to the data type selected for Display C (V, A, W, VA, var, PF, Hz, or deg).

## Analog Trend Recording (Using IC Memory Card)

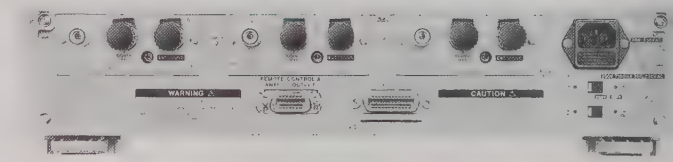
Up to 10 data types can be saved simultaneously to an IC memory card (sold separately) for later trend recording on Yokogawa laboratory instrumentation recorders (LR- or HR-Series) equipped with IC memory card interfaces. The cards can also be used to save panel setup information for quick, sure repitition of measurement setups.

- Three phase four wire measurement has 10-Data functions recorded on IC Card. Please use HR recorder. For 3-phase 3-wire, 7 data functions are recorded on IC Card. 8-pen LR8100 can be used.





**2534 Rear panel**



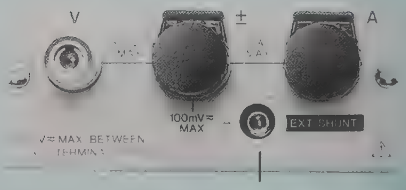
**2535 Rear panel**

## Analyze Data With a Speed Sheet Program

Data saved on the IC memory card can e transferred to a PC using the YOKOGAWA Card Reader. This data can be imported into a spread sheet program for analysis and storage.

## External Shunt Capability

In addition to their basic current input ranges, the Models 2534 and 2535 come standard with external shunt inputs. You can select either 50 mV or 100 mV ranges for these inputs according to your application.



External shunt input terminal

## Specifications

| Item \ Input | Voltage | Current |
|---|---|---|
| Input circuit | Floating input (but no isolation between V and A) | |
| | Resistive voltage divider | Shunt |
| Rated inputs (ranges) | 75/150/300/600V | 1/5/10/20 A<br>(current input)<br>50/100 mV<br>(external shunt input) |
| Input impedance | Input resistance approx. 2 MΩ (all ranges)<br>(Approx. 60 pF in parallel) | Approx. 15 mΩ (all ranges)<br>External shunt input resistance approx. 2 kΩ |
| | Approx. 200 pF between input terminals (±) and case | |
| Frequency range | DC, 10 Hz to 20 kHz | |
| Maximum allowable input (1 sec.) | Peak value 3 times range or 1,400 V, whichever is less | Peak value 7 times range or 70 A, whichever is less<br>External shunt input range: Peak value 5 V max. |
| Maximum allowable input (continuous at 50/60 Hz) | Peak value 1,000 V or rms value of 2 times range, whichever is less | Peak value 50 A, or rms value of 30 A or 3 times range, whichever is less<br>External shunt input range: Peak value 1 V max. |
| Maximum common mode voltage (continuous at 50/60 Hz) | 600 Vrms | 600 Vrms |
| Effect of common mode voltage (at 50/60 Hz) | ±0.03% of range max.<br>(with input terminals shorted and 600 V applied between input and case) | ±0.03% of range max.<br>(600 V applied between input (±) and case with input terminals open) |
| Input terminals | Binding posts | Large binding posts<br>External shunt input: Safety terminal |
| Overrange detection | V range: Approx. 2.5 times range<br>A range: Approx. 3 times range (displays -PO-) | |
| A-D converter | Simultaneous sampling of voltage and current inputs<br>Resolution: 12-bit<br>Maximum conversion rate, approx. 42 kHz | |
| Range switching | V and A can be switched independently using manual, automatic, or external control (GP-IB and RS-232-C) | |
| Auto range switching | Range up: When measured value exceeds 110% of rated value<br>Range down: When measured value is less than 50% of rated value. On 5 A range, when measured value is 20% or less of rated value. | |

## Computing Functions

| | | Apparent power | Reactive power | Power factor | Phase angle |
|---|---|---|---|---|---|
| Computation formula | 1-phase 2-wire | $V \times A$ | $\sqrt{(V \times A)^2 - W^2}$ | $\frac{W}{V \times A}$ | $\cos^{-1}(\frac{W}{V \times A})$ |
| | 1-phase 3-wire | $VA_i = V_i \times A_i$<br>$(i=1, 3)$<br>$\Sigma VA = VA_1 + VA_3$ | $var_i = \sqrt{VA_i^2 - W_i^2}$<br>$(i=1, 3)$<br>$\Sigma var = var_1 + var_3$ | $PF_i = \frac{W_i}{VA_i}$<br>$(i=1, 3)$<br>$\Sigma PF = \frac{\Sigma W}{\Sigma VA}$ | $\phi_i = \cos^{-1}\frac{W_i}{VA_i}$<br>$(i=1, 3)$<br>$\Sigma\phi = \frac{\phi_1 + \phi_3}{2}$ |
| | 3-phase 3-wire (two power-meter method) | $VA_i = V_i \times A_i$<br>$(i=1, 3)$<br>$\Sigma VA = \frac{\sqrt{3}}{2}(VA_1 + VA_3)$ | $var_i = \sqrt{VA_i^2 - W_i^2}$<br>$(i=1, 3)$<br>$\Sigma var = var_1 + var_3$ | $PF_i = \frac{W_i}{VA_i}$<br>$(i=1, 3)$<br>$\Sigma PF = \frac{\Sigma W}{\Sigma VA}$ | $\phi_i = \cos^{-1}\frac{W_i}{VA_i}$<br>$(i=1,3)$<br>$\Sigma\phi = \frac{\phi_1 + \phi_3}{2}$ |
| | 3-phase 4-wire | $VA_i = V_i \times A_i$<br>$(i=1, 2, 3)$<br>$\Sigma VA = VA_1 + VA_2 + VA_3$ | $var_i = \sqrt{VA_i^2 - W_i^2}$<br>$(i=1, 2, 3)$<br>$\Sigma var = var_1 + var_2 + var_3$ | $PF_i = \frac{W_i}{VA_i}$<br>$(i=1, 2, 3)$<br>$\Sigma PF = \frac{\Sigma W}{\Sigma VA}$ | $\phi_i = \cos^{-1}\frac{W_i}{VA_i}$<br>$(i=1, 2, 3)$<br>$\Sigma\phi = \frac{\phi_1 + \phi_2 + \phi_3}{3}$ |
| Computation range | | Depends on V and A range (rated value) | Depends on V and A range (rated value)<br>var≥0 | −1 to 0 to 1<br>(V and A both between 10% and 110% of rated value) | 0 to ±90 deg |
| Computation accuracy | | ±0.05% × (VA at rated input) | ±0.05% × (var at rated input) | ±0.002<br>(at power factor=1) | ±0.2 deg<br>(at 60deg phase angle) |

Note 1: The apparent power (VA), reactive power (var), power factor (PF), and phase angle (deg) measurements in this instrument are computed digitally from the voltage, current and active power. If the input is non-sinusoidal, the measured values may differ from those obtained with instruments employing different measurement principles.

Note 2: The lead and lag displays are specified for V and A inputs at 10% or more of rated value and 10 Hz to 1 kHz (reading not displayed if inputs are below 10% or if lead and lag is within ±2 deg of 0). Lead and lag detection accuracy is ±5deg.

## Display Functions

Display: Three separate LED digital displays

| Display | Displayed information | Maximum reading |
|---|---|---|
| A | V, A, W (in 2534, V only) | V: 9750<br>A: 6500<br>(W determined by V and A display maximums)<br>Wh: 999999 to -99999<br>Hz: 9999 |
| B | V, A, W<br>Elapsed integration time (in 2534, A or time only) | |
| C | V, A, W, VA, var, PF, deg, Wh, Hz | |

| | |
|---|---|
| **Units** | m, k, M, V, A, W, VA, var, Hz, Wh, deg, s |
| **Display update interval** | Approx. 500 ms (Sample rate Approx 250 ms) |
| **Response time** | Approx. 1.5 second<br>(Time for displayed value to settle within accuracy specification of final value after step change from 10% to 100% or 100% to 10% of range.) |

### ● Display Scaling Function

| | |
|---|---|
| **Significant digits** | Selected automatically according to th significant digits in th voltage and current ranges |
| **Setting range** | 1.000 to 1000 |
| **Settable parameters** | Display A: PT ratio<br>Display B: CT ratio, external shunt ratio |

### ● Display Averaging Function

| | |
|---|---|
| **Algorithm** | Exponential averaging |
| **Attenuation constant** | 8 (fixed) |

## Measurement Functions

| Function<br>Item | | | Voltage | Current | Power |
|---|---|---|---|---|---|
| Operating principle | | | True RMS, or mean value, selectable (both by digital computation) | True RMS (by digital computation) | Digitally computed |
| Measurement | 2534 | Single phase | $V_1$ | $A_1$ | $W_1$ |
| | 2535 | 3-phase 3-wire | $V_1$、$V_3$、$\frac{V_1+V_3}{2}(\Sigma)$ | $A_1$、$A_3$、$\frac{A_1+A_3}{2}(\Sigma)$ | $W_1$、$W_3$、$W_1+W_3(\Sigma)$ |
| | | 3-phase 4-wire | $V_1$、$V_2$、$V_3$、$\frac{V_1+V_2+V_3}{3}(\Sigma)$ | $A_1$、$A_2$、$A_3$、$\frac{A_1+A_2+A_3}{3}(\Sigma)$ | $W_1$、$W_2$、$W_3$、$W_1+W_2+W_3(\Sigma)$ |
| Frequency range | | | DC、10Hz～20kHz | DC、10Hz～20kHz | DC、10Hz～20kHz |
| Crest factor | | | Max2.5 | Max3 | Same as for voltage and Current |
| Accuracy (display)<br>Conditions:<br>Temperature: 23°C ±3°C<br>Humidity: 45% to 75% R.H.<br>Supply voltage: 100 V ±1%<br>Input waveform: Sine wave<br>Common mode voltage: 0 V<br>Within 90 days after calibration | | | DC:<br>±(0.4% of rdg + 0.2% of range)<br>45≤f≤66 Hz:<br>±(0.4% of rdg + 0.1% of range)<br>25≤f<45 Hz, 66 Hz<f≤2 kHz:<br>±(0.5% of rdg + 0.4% of range)<br>10≤f<25 Hz, 2 k<f≤10 kHz:<br>±1.5% of range<br>10k<f≤20 kHz:<br>±3.5% of range<br>With input at 10% to 110% | Same as for voltage | DC:<br>±(0.4% of rdg + 0.2% of range)<br>When cosϕ=1<br>45≤f≤66 Hz:<br>±(0.4% of rdg + 0.1% of range)<br>25≤f<45 Hz, 66 Hz<f≤2 kHz:<br>±(0.5% of rdg + 0.4% of range)<br>10≤f<25 Hz, 2 k<f≤10 kHz:<br>±1.5% of range<br>10k<f≤20 kHz:<br>±3.5% of range |
| Effect of power factor | | | — | — | ±0.5% of rdg max. at cosϕ=0.5 (50/60 Hz) |
| Temperature coefficient 5 to 20°C, 26 to 40°C | | | ±0.05% of range/°C max. | Same as for voltage | Same as for voltage |

## Frequency Measurement

**Operating principle** : Reciprocal counting method
**Input** : Voltage or current ( selectable )
**Accuracy** : ±(0.1% of rdg + 1 digit)
**Minimum input** : 10% of range
**Display range** : 4.00 Hz to 22.00 kHz

| Filter | Frequency measurement range |
|---|---|
| ON | 4 Hz ~ 300 Hz |
| OFF | 4 Hz ~ 22 kHz |

## Integration Functions

**Maximum display** : 999999 to -99999
**Maximum integration time**: 99 h:59 min
**Frequency range** : DC, 10 Hz to 20 kHz
**Display** : Displays 'Wh' on Display C
**Timer** : Enables automatic stopping of integration at preset time.
Setting: 00h: 00 min to 99h: 59 min
(00h:00 min selects manual mode)
**Elapsed time** : Elapsed time from integration start is indicated on Display B
**Count overflow** : If integration count overflows the maximum displayable value, integration stops and elapsed time is held on display.
**Accuracy** : Display accuracy ±0.2% of rdg
**Timer accuracy** : 0.02%
**Remote control** : Start, stop, and reset can be remotely controlled by external contact signals

## IC Memory Card

The instruments can use an IC memory card with a capacity of up to 64K bytes to store and recall measured and computed data, and/or to save and load panel setups.

## D-A Converter

**Operating principle** : 15-bit PWM system
**Output voltage** : ±5 V DC at rated value or range (maximum, approx. 7.5 V DC)
**Accuracy** : Display accuracy ±0.2% of F.S.
**Temperature coefficient**: ±0.05% of F.S./°C
**Output data** : Data displayed on Display C (one of the following: V, A, W, VA, var, PF, deg, Hz)
**Output update rate** : Same as display update
**Response time** : Display response + approx. 500 ms

## Communication Specifications (Optional Function)

**GP-IB**
Electrical and mechanical specifications:
Conforms to IEEE St'd 488-1978
Interface functions:
SH1, AH1, T5, L4, SR1, RL1, PP0, DC1, DT1, C0

**RS-232-C**
Transmission mode: Start-stop synchronization
Baud rate: 1200, 2400, 4800, 9600 bps

## ■ General Specifications

External control and output signals:

| Signal name | Input/output | Operation | Levels |
|---|---|---|---|
| EXT HOLD | Input | Display hold | TTL |
| EXT TRIG | Input | Display update | TTL |
| INTEG START | Input | Integration start | TTL |
| INTEG STOP | Input | Integration stop | TTL |
| INTEG RESET | Input | Integration reset | |
| INTEG BUSY | Output | Integration in progress | TTL |

| | |
|---|---|
| **Operating temperature/humidity range** | 5 to 40°C, 20% to 80% R.H. |
| **Warm-up time** | Approx. 30 min. (to meet all specifications) |
| **Insulation resistance** | 500 V DC, 50 MΩ minimum (each input terminal to case; each input terminal to output terminals; each input terminal, output terminal, or case to power supply) |
| **Dielectric withstanding voltage** | 2,200 V AC, 50/60 Hz for 1 min. (each input terminal to case; each input terminal to output terminals; each input terminal to power supply) 1,500 V AC, 50/60 Hz for 1 min. (output terminals or case to power supply) |
| **Power supply** | 100, 115, 200, 230 V, 50/60 Hz (selectable) |
| **Power consumption** | Approx. 20 to 30 VA |
| **Dimensions** | Approx. 88 x 213 x 350 mm (2534)<br>(3.5 x 8.5 x 13.75 inches)<br>Approx. 88 x 426 x 350 mm (2535)<br>(3.5 x 16.75 x 13.75 inches) |
| **Weight** | Approx. 4.5 kg (10 lbs) (2534), approx. 8 kg (17.5 lbs) (2535) |
| **Accessories** | One power cord, Two fuses (one installed in main unit), One remote control connector, One instruction manual. |

## ■ Wiring Connections

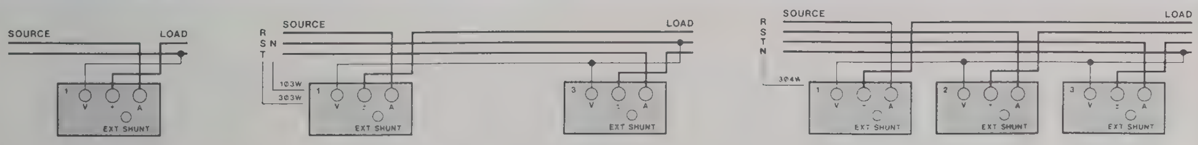
| Wiring \ Model | 253410 | 253520 | 253530 |
|---|---|---|---|
| 1φ 2 w | ○ | ○ | ○ |
| 1φ 3 w | — | ○ | ○ |
| 3φ 3 w (V x 2, A x 2) | — | ○ | ○ |
| 3φ 3 w (V x 3, A x 3) | — | — | — |
| 3φ 4 w | — | — | ○ |

## ■ Model and Suffix Codes

| Model | Suffix code | | | | Description |
|---|---|---|---|---|---|
| 2534 10 | | | | | Single phase |
| 2535 20 | | | | | 3-phase 3-wire |
| 2535 30 | | | | | 3-phase 4-wire |
| Version | -A | | | | |
| Power voltage | | -1 | | | 100V |
| | | -3 | | | 115V |
| | | -5 | | | 200V |
| | | -7 | | | 230V |
| Power cord | | | /M | | JIS standard |
| | | | /D | | UL standard |
| | | | /F | | VDE standard |
| | | | /G | | SAA standard |
| | | | /J | | BS standard |
| Optional features | | | | /C1 | GP-IB interface |
| | | | | /C2 | RS-232-C interface |

## ■ Accessories (Sold Separately)

| Name | Model or part number | Description | Unit of sale |
|---|---|---|---|
| IC memory card | 3789 01 | 8K bytes | 1 |
| IC memory card | 3789 02 | 16K bytes | 1 |
| IC memory card | 3789 03 | 64K bytes | 1 |
| Dummy card for memory card slot | B9586NG | Dust cover | 2 |
| Battery | B9586JU | Battery for IC memory card | 2 |
| Rack mounting kit | 7515 01 | EIA 2534 single mounting | 1 |
| Rack mounting kit | 7515 02 | EIA 2534 double mounting | 1 |
| Rack mounting kit | 7515 03 | JIS 2534 single mounting | 1 |
| Rack mounting kit | 7515 04 | JIS 2534 double mounting | 1 |
| Rack mounting kit | 7515 07 | EIA 2535 single mounting | 1 |
| Rack mounting kit | 7515 08 | JIS 2535 single mounting | 1 |

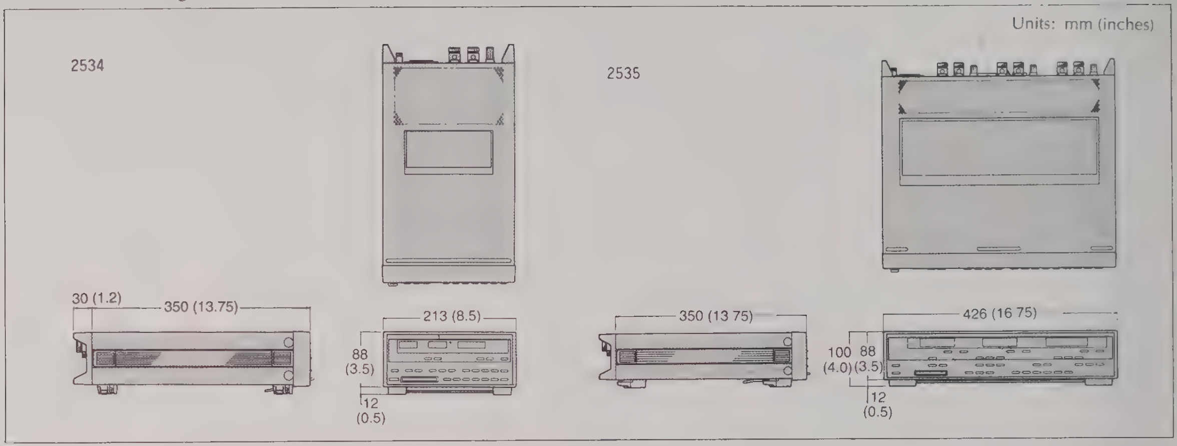


① Single-phase 2-wire

②Single-phase 3-wire
3-phase 3-wire

③3-phase 4-wire

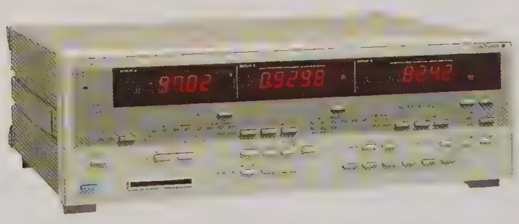
## Outline Drawings



## Related Products

### Digital Power Meter **2532**

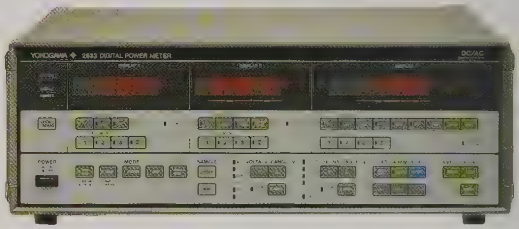
For wide frequency range applications: DC and 20 Hz to 400 kHz



- Low-power measurements down to 2 mW
- High accuracy even at low power factor

### Digital Power Meter **2533**

A full line with configurations for: AC or AC/DC single-phase, 3-phase 3-wire, and 3-phase 4-wire measurements.



- Frequency response: DC, 10 Hz to 20 kHz
- High accuracy: 0.1% (45 to 66 Hz)
- Easy-to read simultaneous 3-value display
- Comes standard with a variety of functions including scaling and averaging

YOKOGAWA

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03

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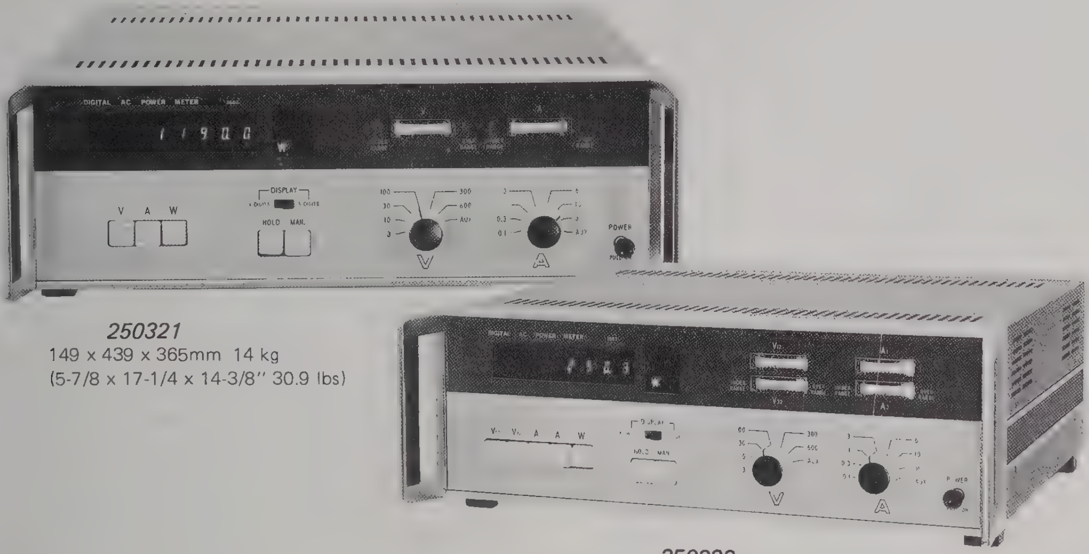
# 2503, 2504, 2505, 2509 & 2513
# Power Measuring Instruments

## 2503 DIGITAL AC POWER METER



*250321*
149 x 439 x 365mm 14 kg
(5-7/8 x 17-1/4 x 14-3/8" 30.9 lbs)

*250323*
149 x 439 x 365mm 16 kg
(5-7/8 x 17-1/4 x 14-3/8" 35.3 lbs)

The accurate measurement of distorted waves, such as thyristor outputs, fluorescent lamps, motors, transformers, and magnetic circuits, has required time-consuming and costly procedures. YEW Model 2503 Digital AC Power Meter now realizes precision RMS measurements of such distorted waves with simple and fast single-touch operation.

Two different models are available—Model 250321 for single-phase circuit and Model 250323 for three-phase three-wire circuit. A single unit of Model 250321 measures true RMS value of voltage from 3 to 600V (25Hz to 2 kHz, also DC-superimposed voltage) and of current from 100mA to 30A (25 Hz to 2 kHz) and power from 300 mW to 18 kW (40 Hz to 1.2 kHz), at 0.1% accuracy. In Model 250323, the respective current and voltage range is the same as Model 250321 and power range is from 600mW to 36kW by means of two-wattmeter method. It can also be used in single-phase circuit.

**Available Models**

| Measuring circuits | With BCD output, remote control and analog output |
|---|---|
| Single-phase | **250321** |
| 3-phase, 3-wire | **250323** |

### MAIN FEATURES

- **True RMS measurements of voltage (3 to 600V), current (100 mA to 30A) and power(300 mW to 18 kW for single-phase, 600 mW to 36 kW for 3-phase 3-wire)**
- **0.1 % accuracy**
- **High resolution—1mV/digit, 10μA/digit, 0.1 mW/digit**
- **Simplified operation**
- **Outstanding overvoltage protection**
- **Superlative noise immunity and stability**
- **Negligible instrument loss**
- **BCD output, remote control and analog output**

# SPECIFICATIONS OF 2503

## GENERAL SPECIFICATIONS

**Type of Input:** Floating

**Display:** LED(light-emitting diode) display

**Sample Rate:** Approx. 1.5 times per second

**Max. Reading:** 11900 (lowest digit can be faded out with selector if not needed)

**Range Selection:** Manual

**Function Selection:** Manual (remote control possible)

**Unit Marks:** V, mA, A, mW, W and kW

**Effective Measuring Range:** 30 to 110% of rated value

**Response Time:** Approx. 1.5 seconds (for reading within specified accuracy against an input variation from 30% to 100% of range or from 100% to 30% of range)

**Operating Temperature Range:** 5 to 40°C(41 to 104°F)

**Humidiyt Range:** 20 to 80%, relative humidity

**Warmup Time:** Approx. 30 minutes (for reading within specified accuracy)

**Output:** BCD (1-2-4-8) code, polarity, unit marks, decimal point, overrange signals

Analog output; (highest or lowest three digits of BCD output are converted to analog voltage)0 to ±11.99V (mV) DC for highest three digits, 0 to ±9.99V(mV) DC for lowest three digits

**Accuracy of D-A Conversion:** Corresponds to ±2 digits for 10V output, corresponds to ±10 digits for 10 mV output

**Power Requirements:** 100, 115, 200, 215 or 230V AC, 50 or 60 Hz (must be specified)

**Power Supply Fluctuation:** ±0.03% of range against a power supply variation of ±10% of rated value

**Dielectric Strength:** 2,200V AC 50 Hz for one minute between input terminals and case, and between input and output terminals, 1,500V AC 50 Hz for one minute between case and power supply circuit, and between output terminals and power supply circuit

**Insulation Resistance:** More than 50 MΩ at 500V DC (except between output terminals and case)

**Power Consumption:** Approx. 27 VA (250321), 34 VA (250323)

**Accessories supplied at no extra cost:** Power cord(2- or 3-prong type) . . . . . . 1 set, fuses(1A) . . . . . . 2 pcs., aux. input cord . . . . . 1 set(250321), 2 sets(250323), connectors(AMPHENOL 57-30240 and 57-30500) . . . . . . 1 set

## VOLTAGE

**(Single-phase V, 3-phase 3-wire V12 and V32)**

**Operating Principle:** Steepest descent method

**Ranges:** 3, 10, 30, 100, 300, 600V(6 ranges)

**Resolution:** 1 mV/digit

**Frequency Range:** DC and 25 Hz to 2 kHz

**Crest Factor:** Up to 3(1,000V peak max.) at rated value

**Accuracy:** (sine wave input, 3-month calibration cycle, 23 ±3°C)

±(0.1% of reading +0.02% of range + 1 digit) for 50 to 400 Hz

±(0.2% of reading +0.03% of range +1 digit) for DC, 25 to 50 Hz and 400 Hz to 2 kHz

**Temperature Coefficient:** (5 to 20°C and 26 to 40°C, and frequency range of 50 Hz to 1 kHz), Less than ±0.02% of range/°C

**Input Impedance:** Approx. 10kΩ/V, 330 pF on 3V to 100V ranges, Approx. 1MΩ shunted by 330pF on 300V and 600V ranges

**Allowable Input Voltage (continuous):** 3 x range or 1,000V peak, whichever is less

**Allowable Input Voltage (for less than one second):** 7 x range or 1,500V peak, whichever is less

**Common Mode Voltage:** 1,000V at 50 or 60 Hz

**Common Mode Rejection:** 100dB(1,000 V applied between input terminal and case)

**Auxiliary Input Terminals:** Input voltage; 1V (input resistance; 10kΩ)

## CURRENT

**Operating Principle:** Steepest descent method

**Ranges:** 100, 300, 1,000mA, 3, 6, 10, 30A(7 ranges)

**Resolution:** 10μA/digit

**Frequency Range:** 25 Hz to 2 kHz

**Crest Factor:** Up to 3(70A peak max.) at rated value

**Accuracy:** (sine wave input, 3-month calibration cycle, 23 ±3°C)

±(0.1% of reading + 0.02% of range + 1 digit) for 50 to 400 Hz

±(0.2% of reading + 0.03% of range + 1 digit) for 25 to 50 Hz and 400 Hz to 2 kHz

**Temperature Coefficient:** (5 to 20°C and 26 to 40°C, and frequency range of 50 Hz to 1 kHz), Less than ±0.02% of range/°C

**Power Consumption:** (Approx.) 0.03 VA on 0.1A range, 0.04 VA on 0.3 A range, 0.08 VA on 1A range, 0.2 VA on 3A range, 0.5 VA on 6A range, 1VA on 10A range, 3VA on 30A range

**Allowable Input Current (continuous):** 3 x range or 70A peak, whichever is less

**Allowable Input Current (for less than one second):** 10 x range or 100A peak, whichever is less

**Common Mode Voltage:** 1,000V at 50 or 60 Hz

**Effect of Common Mode Voltage:** (at 50 or 60 Hz) ±0.02% of range for the application of 1,000V between input terminal and case

**Auxiliary Input Terminals:** Input voltage; 1V (input resistance; approx. 10kΩ)

## POWER(single-phase)

**Operating Principle:** Feedback time division multiplier method

**Ranges:** 300mW to 18kW (V range X A range)

**Resolution:** 0.1 mW/digit

**Frequency Range:** 40 Hz to 1.2 kHz

**Crest Factor:** Corresponds to those of V and I measurements

**Accuracy:** (sine wave input, 90-day calibration cycle, 23 ±3°C)

At cos $\phi = 1$

±(0.1% of reading + 0.02% of range + 1 digit) for 50 to 400 Hz

±(0.2% of reading + 0.03% of range + 1 digit) for 40 to 50 Hz and 400 Hz to 1.2 kHz

**Effect against Variation of Power Factor:** Less than ±0.1% of reading (cos $\phi$ from 1 to 0.5 at 50 or 60 Hz, at rated voltage

**Temperature Coefficient:** (5 to 20°C and 26 to 40°C and frequency range of 50 Hz to 1kHz), Less than ±0.02% of range/ °C

**Input Impedance and Power Consumption:** Corresponds to those of the V and I measurements

**Allowable Input Voltage:** Corresponds to those of V and I measurements

**Common Mode Voltage:** Corresponds to those of the V and I measurements

**Effect of Common Mode Voltage:** (at 50 or 60 Hz)
±0.02% of range for the application of 1,000V between voltage and current terminals, and between input terminal and case

**Auxiliary Input Terminals:** Corresponds to those of V and I measurements

## POWER (3-phase 3-wire)

**Operating Principle:** Feedback time division multiplier method

**Ranges:** 600mW to 36 kW, ($V_{12}$ range X $A_1$ range) + ($V_{32}$ range X $A_3$ range)

**Resolution:** 0.1mW/digit

**Frequency Range:** 40 Hz to 1.2 kHz

**Crest Factor:** Corresponds to those of V and I measurements

**Accuracy:** (sine wave input, 3-month calibration cycle, 23±3°C)
At cos $\phi$=1
±(0.1% of reading + 0.02% of range + 1 digit) for 50 to 400 Hz
±(0.2% of reading + 0.03% of range + 1 digit) for 40 to 50 Hz and 400 Hz to 1.2 kHz

**Effect against Variation of Power Factor:** Less than ±0.2% of reading (cos $\phi$ from 1 to 0.5 at 50 or 60 Hz, at rated voltage)

**Temperature Coefficient:** (5 to 20°C and 26 to 40°C and frequency range of 50 Hz to 1kHz)
Less than ±0.02% of range/°C

**Input Impedance and Power Consumption:** Corresponds to those of the V and I measurements

**Allowable Input Voltage:** Corresponds to those of V and I measurements

**Common Mode Voltage:** Corresponds to those of the V and I measurements

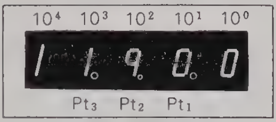
**Effect of Common Mode Voltage:** (at 50 or 60 Hz)
±0.02% of range for the application of 1,000V between voltage and current terminals, and between input terminal and case

**Auxiliary Input Terminals:** Corresponds to those of V and I measurements

**Effect against Mutual Interference:** Less than ±0.1% of range

### BCD Output Connector (AMPHENOL 57-30500)

| Pin No. | | | | Pin No. | | |
|---|---|---|---|---|---|---|
| 1 | 1 | X10⁰ | BCD output | 26 | 28 | Unit marks output |
| 2 | 2 | | | 27 | | |
| 3 | 4 | | | 28 | | |
| 4 | 8 | | | 29 | | |
| 5 | 1 | X10¹ | | 30 | | |
| 6 | 2 | | | 31 | | |
| 7 | 4 | | | 32 | mA | |
| 8 | 8 | | | 33 | A | |
| 9 | 1 | X10² | | 34 | | |
| 10 | 2 | | | 35 | V | |
| 11 | 4 | | | 36 | W | |
| 12 | 8 | | | 37 | kW | |
| 13 | 1 | X10³ | | 38 | Overrange | |
| 14 | 2 | | | 39 | — | |
| 15 | 4 | | | 40 | | |
| 16 | 8 | | | 41 | | |
| 17 | 1 | X10⁴ | | 42 | PT1 | Decimal point |
| 18 | | | | 43 | PT2 | |
| 19 | | | | 44 | PT3 | |
| 20 | | | | 45 | | |
| 21 | | | | 46 | | |
| 22 | | | | 47 | Busy | |
| 23 | | | | 48 | End Pulse | |
| 24 | EXT Start | | | 49 | Dig. Com | |
| 25 | EXT Hold | | | 50 | + 5V | |



### Level and Type of Input/Output Circuits

| | Signal | Level | | Data |
|---|---|---|---|---|
| | | "0" | "1" | |
| Input | Ext. Start<br>Ext. Hold | 0 to 0.5V | +2.4 to 5V | L |
| Output | BCD, Overrange,<br>Porality sign,<br>Unit marks,<br>Decimal point | 0 to 0.5V | More than +2.4V | H |
| | Busy | 0 to 0.5V | More than +2.4V | L |
| | End Pulse | 0 to 0.5V | More than 4.5V | L |

### Remote Input Connector (AMPHENOL 57-30240)

| Pin No. | Single-phase | 3-phase 3-wire | | Pin No. | | |
|---|---|---|---|---|---|---|
| 1 | V | V12 | FUNCTION | 13 | 10V | Analog Output |
| 2 | | V32 | | 14 | 10mV | |
| 3 | A | A1 | | 15 | U/L | |
| 4 | | A3 | | 16 | SG | |
| 5 | W | W1 | | 17 | | |
| 6 | | W3 | | 18 | | |
| 7 | | W(W1+W3) | | 19 | | |
| 8 | Selection | Selection | | 20 | Overrange | |
| 9 | | | | 21 | Busy | |
| 10 | | | | 22 | End Pulse | |
| 11 | Ext Start | | | 23 | Dig Com(OV) | |
| 12 | Ext Hold | | | 24 | + 5V | |

### Level and Type of Input/Output Circuits

| | Signal | Level | | Data |
|---|---|---|---|---|
| | | "0" | "1" | |
| Input | Function | 0 to 0.5V | More than +2.4V | L |
| | Ext. Start<br>Ext. Hold | 0 to 0.5V | More than +2.4V | L |
| | U/L | 0 to 0.5V | Less than +2.4V | H/L |
| Output | Overrange<br>Busy | 0 to 0.5V | More than +2.4V | H/L |
| | End Pulse | 0 to 0.5V | More than +2.4V | L |

# 2504 DIGITAL AC METER

149 x 233 x 364mm
(5-7/8 x 9-1/4 x 14-3/8″)

Model 2504 is used in a single-phase circuit for measuring true rms value of voltage, current and/or power with ±0.25% accuracy.

Model 2504 consists of a mainframe and a plug-in input module. The measuring functions (W or V-A-W) are selected from mainframes and input by three types of plug-in modules. By using a DC Input Module, Model 2504 is also usable for voltage, current and wattage measurements of DC and DC-superimposed AC. Moreover, analog outputs of V, A and W are provided as a standard feature to interface with analog recording instruments.

**Available Models**
**Mainframe**

| Name | Code | Function |
|---|---|---|
| Digital AC Meter | **250431** | W direct reading (with BCD output, mote control and analog output) |
| | **250432** | V-A-W direct reading (with BCD output, remote control and analog output) |

**Plug-In Input Modules**

| Name | Code | Type of Input | Input Ranges |
|---|---|---|---|
| Multi-Range Input Module | **251406** | PT/CT | 30V/60V/100V/150V/300V, 0.5A/1A/2A/5A/10A |
| | **251407** | | 100V/150V/300V/600V, 2A/5A/10A/20A |
| DC Input Module | **251416** | Isolation amp, (V)/ DC CT (A) | 30V/60V/100V/150V/300V, 0.5A/1A/2A/5A/10A |

## MAIN FEATURES

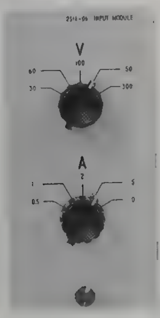
- **True RMS V-A and/or W measurements**
- **DC and DC-superimposed AC measurements**
- **Frequency range from 25 Hz to 2 kHz**
- **±0.25% accuracy**
- **Time division multiplier**

## SPECIFICATIONS

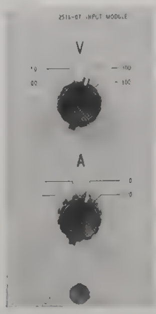
### GENERAL SPECIFICATIONS

**Operating Principle:** Log rms-to-DC conversion system (for voltage and current measurements). Feedback time division multiplier method (for power measurement)
**Type of Input:** Floating
**Display:** LED (light-emitting diode) display
**Sample Rate:** Approx. 1.5 times per second
**Max. Reading:** 11900
**Range Selection:** Manual
**Function Selection:** Manual (remote control possible)
**Unit Marks:** V, mA, A, W and kW
**Effective Measuring Range:** 30 to 110% of rated value
**Response Time:** Approx. 2 seconds (for reading within specified accuracy against the input variation from 30 to 100% of range or from 100 to 30% of range)
**Operating Temperature Range:** 5 to 40°C (41 to 104°F)
**Humidity Range:** 20 to 80% (relative humidity)
**Warmup Time:** Approx. 30 minutes (for reading within specified accuracy)
**Analog Output:** 0 to ±5V DC, 5V DC for rated input, max. load current; 1 mA, accuracy; ±0.3% of rated value
**Channel Output:** Vrms and Arms (0 to 1 Vrms, 1 Vrms for rated input), max. load current; 1 mA
**Remote Control:** Unit mark display and scaling are remotely controlled. For remote control of digital display, an external selector switch is required (to be prepared by user)
**BCD Output and Remote Control:** BCD (1-2-4-8) code, unit marks, decimal point and overrange signal
**Power Requirements:** 100, 115, 200, 215 or 230V AC, 50 or 60 Hz (must be specified)
**Power Supply Voltage Fluctuation:** ±0.05% of range against a power supply variation of ±10% of rated value
**Dielectric Strength:** 2,200 V AC 50 Hz (1,600 V AC 50 Hz for 251416) for one minute between input terminals and case, and between input and output terminals, 1,500 V AC, 50 Hz for one minute between case and power line, and between putput terminals and power line
**Insulation Resistance:** More than 50MΩ at 500V DC (except between output terminals and case)
**Power Consumption:** Approx. 22 VA
**Weight:** Mainframe (including case): approx. 6.5 kg (14.3 lbs), input module; approx. 2.6 kg (5.7 lbs)
**Accessories supplied at no extra cost:** Power cord (2- or 3-prong type) . . 1 set, fuses (1A) . . 2 pcs., analog output connector (AMPHENOL 57-30240) . . 1 pcs., BCD output and remore control connector (AMPHENOL 57-30500) . . 2 pcs..

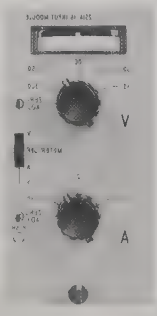
| Measurement Function | Code | Voltage | | Current | | Power (for single-phase circuit) | |
|---|---|---|---|---|---|---|---|
| **Input Ranges (Type of Input)** | **251406** | 30/60/100/150/300V | (potential transformer) | 0.5/1/2/5/10A | (current transformer) | 15W to 3 kW | (corresponds to V and A measurements) |
| | **251407** | 100/150/300/600V | | 2/5/10/20A | | 200W to 12 kW | |
| | **251416** | 30/60/100/150/300V | (isolation amplifier) | 0.5/1/2/5/10A | (DC current transformer | 15W to 3 kW | |
| **Resolution** | | 10 mV/digit | | 1 mA/digit (0.1 mA/digit for 251406 and 251416) | | 100 mW/digit (10 mW/digit for 251406 and 251416) | |
| **Frequency Range** | | 25 Hz to 2 kHz (DC, 25 Hz for 2 kHz for 251416) | | 25 Hz to 2 kHz (DC, 25 Hz to 1.2 kHz for 251416) | | 40 Hz to 1.2 kHz (DC, 40 Hz to 1.2 kHz for 251416) | |
| **Crest Factor** | | Up to 2, 1,000V pk max. | | Up to 3, 1,000V pk max. | | corresponds to those of V and A measurements | |
| **Accuracy** (sine wave, 3-month calibration cycle, temperature range of 23 ± 3°C) | | 47 Hz to 63 Hz (DC, 47 Hz to 63 Hz for 251416):<br>±(0.25% of reading + 0.05% of range)<br>25 Hz to 47 Hz and 63 Hz to 2 kHz:<br>±(0.5% of reading + 0.1% of range) | | 47 Hz to 63 Hz (DC, 47 Hz to 63 Hz for 251416):<br>±(0.25% of reading + 0.05% of range)<br>25 to 47 Hz and 63 Hz to 2 kHz:<br>±(0.5% of reading + 0.1% of range) | | cos $\phi$ = 1, 47 Hz to 63 Hz (DC, 47 Hz to 63 Hz for 251416),<br>±(0.25% of reading + 0.05% of range)<br>40 Hz to 47 Hz and 63 Hz to 1.2 kHz:<br>±(0.5% of reading + 0.1% of range) | |
| **Effect against Variation of Power Factor** (cos $\phi$ = 0.5, at 50 or 60 Hz) | | – | | – | | Less than ±0.25% of reading | |
| **Temperature Coefficient** (temperature range of 5 to 20°C and 26 to 40°C, and at 50 Hz to 1 kHz, at DC for 251416) | | Less than ±0.05% of range / °C | | Less than ±0.05% of range / °C | | Less than ±0.025% of range / °C | |
| **Input Impedance and Power Consumption** approx. value at 50Hz (approx. value at DC for 251416) | | 5kΩ (60 kΩ) on 30 V range<br>20 kΩ (120 kΩ) on 60 V range<br>50 kΩ (200 kΩ) on 100V range<br>100 kΩ (300 kΩ) on 150V range<br>400 kΩ (600 kΩ) on 300V range<br>1.5 MΩ on 600V range | | 0.05VA (0.1 VA) on 0.5A range<br>0.07VA (0.1VA) on 1A range<br>0.1VA (0.2VA) on 2A range<br>0.4VA (0.5VA) on 5A range<br>1VA (2VA) on 10A range<br>2VA on 20A range | | corresponds to those of V and A measurements | |
| **Max. Allowable Input** (continuous) | | 3 x range, peak value [251416: 2 x range (peak value) or 1.5 x range (RMS value), whichever is less] | | 3 x range, peak value [251416: 2 x range (peak value) or 1.5 x range (RMS value), whichever is less] | | | |
| **Max. Allowable Input** (for less than 1 second) | | 3.5 x range, peak value (2.5 x range for 251416) | | 10 x range, peak value (3.5 x range for 251416) | | | |
| **Common Mode Voltage** | | 1,000V pk | | 1,000V pk | | | |
| **Common Mode Rejection or Effect of Common Mode Voltage** (1,000V applied between input terminals and case) | | More than 80 dB | | ±0.025% of range | | | |
| **Dimensions** | | 138 x 70 x 368 mm (5-1/2 x 2-3/4 x 14-1/2") | | | | | |



*251406*
*Multi-Range*
*Input Module*



*251407*
*Multi-Range*
*Input Module*



*251416*
*DC Input*
*Module*

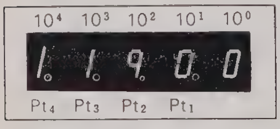
# SPECIFICATIONS OF 2504

## Analog Output Connector (AMPHENOL 57-30140)

| Pin No. | | | Pin No. | |
|---|---|---|---|---|
| 1 | V output | Analog output | 8 | |
| 2 | A output | | 9 | |
| 3 | W output | | 10 | |
| 4 | | | 11 | |
| 5 | | | 12 | |
| 6 | A channel output | | 13 | V channel output |
| 7 | Ext A/D input | | 14 | Com |

## BCD Output Connector (AMPHENOL 57-30500)

| Pin No. | | | | Pin No. | | |
|---|---|---|---|---|---|---|
| 1 | 1 | X $10^0$ | BCD output | 26 | | Unit mark output |
| 2 | 2 | | | 27 | | |
| 3 | 4 | | | 28 | | |
| 4 | 8 | | | 29 | | |
| 5 | 1 | X $10^1$ | | 30 | | |
| 6 | 2 | | | 31 | | |
| 7 | 4 | | | 32 | mA | |
| 8 | 8 | | | 33 | A | |
| 9 | 1 | X $10^2$ | | 34 | | |
| 10 | 2 | | | 35 | V | |
| 11 | 4 | | | 36 | W | |
| 12 | 8 | | | 37 | kW | |
| 13 | 1 | X $10^3$ | | 38 | Overrange | |
| 14 | 2 | | | 39 | | |
| 15 | 4 | | | 40 | " — " | |
| 16 | 8 | | | 41 | | |
| 17 | 1 | X $10^4$ | | 42 | Pt 1 | Decimal point |
| 18 | | | | 43 | Pt 2 | |
| 19 | | | | 44 | Pt 3 | |
| 20 | | | | 45 | Pt 4 | |
| 21 | | | | 46 | | |
| 22 | | | | 47 | Busy | |
| 23 | | | | 48 | End Pulse | |
| 24 | EXT Start | | | 49 | DIG. Com | |
| 25 | EXT Hold | | | 50 | + 5 V | |



## Level and Type of Input/Output Circuits

| | Signal | Level | | Data |
|---|---|---|---|---|
| | | "0" | "1" | |
| Input | Ext. Start<br>Ext. Hold | 0 to 0.5V | + 2.4 to 5V | L |
| Output | BCD, Overrange, Porality sign, Unit marks, Decimal point | 0 to 0.5V | More than + 2.4V | H |
| | Busy | 0 to 0.5V | More than + 2.4V | L |
| | End Pulse | 0 to 0.5V | More than + 4.5V | L |

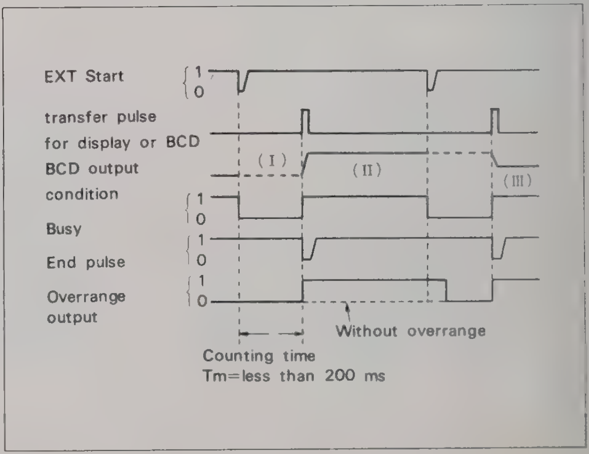
## Remote Input Connector (AMPHENOL 57-30500)

| Pin No. | | | Pin No. | | |
|---|---|---|---|---|---|
| 1 | 600V | V Range | 26 | 20A | A Range |
| 2 | 300V | | 27 | 10A | |
| 3 | 150V | | 28 | 5A | |
| 4 | 100V | | 29 | 2A | |
| 5 | 60V | | 30 | 1A | |
| 6 | 30V | | 31 | 0.5A | |
| 7 | | | 32 | | |
| 8 | | | 33 | | |
| 9 | PWM | | 34 | Ext Function Sel. | |
| 10 | f (scale frequency) | | 35 | Ext Range Sel. | |
| 11 | 480kHz | | 36 | | |
| 12 | | | 37 | | |
| 13 | | Function | 38 | | Unit mark output |
| 14 | | | 39 | | |
| 15 | W | | 40 | | |
| 16 | V | | 41 | | |
| 17 | | | 42 | | |
| 18 | | | 43 | | |
| 19 | A | | 44 | mW | |
| 20 | | | 45 | | |
| 21 | | | 46 | | |
| 22 | | | 47 | Busy | |
| 23 | | | 48 | End Pulse | |
| 24 | Ext Start | | 49 | Dig Com | |
| 25 | Ext Hold | | 50 | + 5V | |

Note: Scale frequency=480 x (full scale value)/1,000 kHz

## Level and Type of Input/Output Circuits

| | Signal | Level | | Data |
|---|---|---|---|---|
| | | "0" | "1" | |
| Input | Function | Closed Contact | Open Contact | L |
| | Ext. Start<br>Ext. Hold | 0 to 0.5V | More than +2.4V | L |
| | Ext Function Sel. | 0 to 0.5V | More than +2.4V | L |
| | Ext Range Sel. | 0 to 0.5V | More than +2.4V | H/L |
| | V Range<br>A Range | Closed Contact | Open Contact | L |
| Output | Overrange<br>Busy | 0 to 0.5V | More than +2.4V | H/L |
| | End Pulse | 0 to 0.5V | More than +2.4V | L |



# 2505 DIGITAL AC METER

149 x 444 x 364mm 16.3 kg
(5-7/8 x 17-1/2 x 14-3/8" 35.9 lbs)

Model 2505 is used in 3-phase 4-wire circuit for measuring true rms value of voltage and current, and power all at ±0.25% accuracy. Merely by depressing front-panel push-button, Model 2505 provides direct digital reading of voltage, current or power in each phase, or total power by means of three-wattmeter method.

**Available Models**

| Name | Composition | Code | Description |
|---|---|---|---|
| Digital AC Meter (for 3-phase 4-wire circuit) | Mainframe | **250531** | V, A and W measurements (with analog output, BCD output and remote control) |
| | Multi-range input module | **251447** | Input ranges: 100V/150V/300V/600V, 2A/5A/10A/20A |
| | Mainframe and input module | **250534** | 250531 and 251447 |

## MAIN FEATURES

- **Direct digital reading of power in 3-phase 4-wire circuit (or voltage, current and power in each phase)**
- **±0.25% accuracy**
- **Accurate reading even for unbalanced 3-phase circuit**
- **Precision power measurement by patented feedback time division multipliers (three-wattmeter method)**
- **True RMS measurement by log RMS-to-DC conversion system**
- **Voltage and current overrange indicator in each phase**
- **Minimized instrument loss**
- **Foolproof front-panel pushbutton operation**
- **Easy-to-read, long-life LED (Light-Emitting Diode) display**
- **Analog/BCD outputs and remote control (standard)**

## SPECIFICATIONS

### GENERAL SPECIFICATIONS

**Operating Principle:** Log rms-to-DC conversion system (V and A measurements), feedback time division multiplier (W measurement)

**Type of Input:** Floating

**Display:** LED (light-emitting diode) display

**Sample Rate:** Approx. 1.5 times per second (remote control possible)

**Maximum Reading:** 11900

**Range Selection:** Manual

**Function Selection:** Manual (remote control possible)

**Unit Marks:** V, mA, A, W and kW

**Effective Measuring Range:** 30 to 110% of input range (V and A ranges)

**Response Time:** Approx. 2 seconds (for reading within specified accuracy against the input variation from 30 to 100% of range, or from 100 to 30% of range)

**Operating Temperature Range:** 5 to 40°C (41 to 104°F)

**Humidity Range:** 20 to 80% (relative humidity)

**Warmup Time:** Approx. 30 minutes (for reading within specified accuracy)

**Analog Output:** 0 to 5 V DC, 5 V DC for rated input, Accuracy; ±0.3% of range for 47 to 63 Hz, ±0.6% of range for other frequency ranges, Max. load current; 1 mA, Max. load capacitance; 0.05 μF

**Channel Output:** 1 V rms for rated input, Max. load current; 1 mA, Max. load capacitance; 50 pF

**BCD Output and Remote Control:** BCD (1-2-4-8) code, unit marks, decimal point and overrange signal [remote control possible by using an external selector (to be prepared by user)]

**Power Requirements:** 100, 115, 200, 215 or 230V AC, 50 or 60 Hz, (must be specified)

**Effect of Power Supply Voltage Fluctuation:** ±0.05% of range against power supply voltage fluctuation of ±10% of rated value

**Dielectric Strength:** 2,200V AC, 50 or 60 Hz for one minute between input terminals and case, between input and output terminals, between voltage and current terminals, and between current terminals
1,500 V AC, 50 or 60 Hz for one minute between case and power line, and between output terminals and power line

**Insulation Resistance:** More than 500 MΩ at 500 V DC between input terminals and case, between input and output terminals, between current terminals, between output terminals and power line, and between case and power line

**Power Consumption:** Approx. 25 VA

**Accessories supplied at no extra cost:** Power cord (2- or 3-pin system) . . 1 set, fuses (2A) . . 2 pcs., analog output connectors (AMPHENOL 57-30240) . . 3 pcs., BCD output and remote control connectors (AMPHENOL 57-30500) . . 2 pcs.

# 2509 DIGITAL WATTMETER

90 x 210 x 330mm 3.1 kg
(3-5/8 x 8-1/4 x 13" 6.6 lbs)

Model 2509 is a true rms digital V-A and W meter. It provides three measurement functions all at ±0.5% accuracy.

## SPECIFICATIONS

**Type of Input:** Floating.
**Maximum Reading:** 5990.
**Effective Measuring Range:** 30 to 110% of input range (V and I).
**Response Time:** Approx. 3 seconds.
**Operating Temperature Range:** 5 to 40°C(41 to 104°F).
**Humidity Range:** 20 to 80%, relative humidity.
**Power Requirements:** 100, 120, 200, 220 or 240V AC ±10% (must be specified), 50 and 60Hz.
**Dielectric Strength:** 1,500V AC, 50 Hz for one minute between V and I terminals, and between input terminal and power line.
**Insulation Resistance:** More than 20MΩ at 500V DC.

| Measurement Function | Voltage | Current | Power (for single-phase circuit) |
|---|---|---|---|
| **Input Ranges** | 250V | 1, 2, 5, 10A | 250, 500, 1,250, 2,500W (V range x A range) |
| **Resolution** | 100m V/digit | 1m A/digit | 100mW/digit |
| **Frequency Range** | 40Hz to 400Hz | 40Hz to 400Hz | 40Hz to 400Hz |
| **Crest Factor** | Up to 2 at rated value | Up to 3 at rated value | Corresponds to V and A measurements |
| **Accuracy** (at 23±3°C, 45 to 75% humidity, 120V ±1% sine wave input, 3-month calibration cycle) | ±(0.5% of reading +0.1% of range) for 47 to 63Hz | ±(0.5% of reading +0.1% of range) for 47 to 63Hz | At cos $\phi$ = 1, ±(0.5% of reading +0.1% of of range) for 47 to 63Hz |
| **Power Factor Influence** (at cos $\phi$ = 0.5, 50 or 60Hz) | — | — | Less than ±0.5% of reading |
| **Temperature Coefficient** (5 to 20°C, 26 to 40°C, 50 or 60 Hz) | Less than ±0.1% of range/°C | Less than ±0.1% of range/°C | Less than ±0.1% of range/°C |
| **Input Impedance or Power Consumption** (approx. value at 50Hz) | 250 kΩ | 0.05VA on 1A range,<br>0.06VA on 2A range,<br>0.2VA on 5A range<br>0.5VA on 10A range | Corresponds to V and A measurements |
| ***Maximum Allowable Input** (continuous) | 2 x range (peak value) | 3 x range (peak value) | |
| ***Maximum Allowable Input** (for less than one second) | 3 x range (peak value) | 5 x range (peak value) | |
| **Common Mode Rejection or Effect of Common Mode Voltage** | More than 80dB | ±0.2% of range | ±0.2% of range |

*Note: The specified values shall apply regardless of the set position of line power switch (ON or OFF).

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Represented by:

Subject to change without notice.

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# 2524
# Digital Power Factor Meter

## True Power Factor for Precision Measurement of Distorted Waves

*2524 (optional function. . .
apparent power)*

The power factor measurement now goes to digital with the new YEW Model 2524 Digital Power Factor Meter. A single unit of Model 2524 measures the power factor of W/Vrms Arms and $W/\sqrt{W^2 + VAR^2}$, true rms voltage, true rms current (basic functions), and active, apparent or reactive power (optional function). At the touch of a button, measured data are directly displayed on the 4-digit LED. Analog output of each measurement is available for continuous recording.

Model 2524 is an outstanding solution to accurate power factor measurement of non-sinusoidal and distorted waves.

## MAIN FEATURES

- **Direct Digital Readout of True Power Factor**
- **Five Measurement Functions All in One Instrument**
  Four basic functions plus one optional function:

| | |
|---|---|
| *Standard functions* | True power factor (W/Vrms Arms)<br>Power factor ($W/\sqrt{W^2 + VAR^2}$)<br>True rms voltage (V)<br>True rms current (A) |
| *Optional function* (one must be specified) | Apparent power (VA)<br>Active power (W)<br>Reactive power (VAR) |

- **Analog Output for Continuous Recording**
- **Easy-to-Read, Bright LED Display**
- **Simple, Quick Operation**
  All measurement functions and ranges are pushbutton selectable.
- **Overrange and Underrange Indicators**
- **Also Usable for 3-Phase Circuits**
  3-phase 3-wire circuit can be measured using two units, 3-phase 4-wire circuit, using three units.
- **Compact, Lightweight—only 3 kg (6.6 lbs)**

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## POWER FACTOR

When the alternating current in a single phase circuit is I, and the voltage is V, the power is equal to the product of V and I multiplied by the cosine of the phase angle between them, and can be obtained from the equation:

$$P = VI \cos\varphi \text{ (W)}$$

This is sometimes called the active power. The reactive power Q is expressed by the formula:

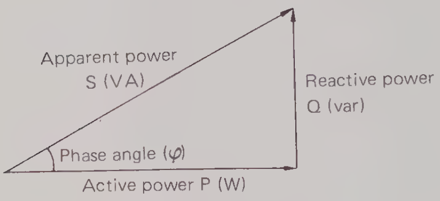
$$Q = VI \sin\phi$$
$$= VI \cos(\varphi - 90^\circ) \text{ (var)}$$

From the relationship shown in the figure, apparent power S is:

$$S = \sqrt{P^2 + Q^2} \text{ (VA)}$$

Then, the power factor can be obtained from the active power and reactive power:

$$\boxed{\text{Power factor} = P/\sqrt{P^2 + Q^2} \cdots\cdots (1)}$$



The current (voltage) of generally-used AC lines (such as those in motors, generators, transformers and power-system electrical equipment) is non-sinusoidal and distorted wave. These can be resolved into sinusoidal fundamental and harmonic components:

$$\text{Apparent power } S = \sqrt{(V_1^2 + V_2^2 + \cdots)(I_1^2 + I_2^2 \cdots)} \text{ (VA)}$$

in which $V_1$ and $I_1$ represent the rms fundamental components, and $V_2 \cdots$ and $I_2 \cdots$, the individual rms harmonic components.

The active power P is:

$$P = V_1 I_1 \cos\varphi_1 + V_2 I_2 \cos\varphi_2 + \cdots\cdots \text{ (W)}$$

Then, the power factor is:

$$\text{Power factor} = \frac{V_1 I_1 \cos\varphi_1 + V_2 I_2 \cos\varphi_2 + \cdots}{\sqrt{(V_1^2 + V_2^2 + \cdots\cdots)(I_1^2 + I_2^2 + \cdots\cdots)}}$$

$$\boxed{= \frac{W}{\text{Vrms Arms}} \cdots\cdots (2) \text{ True power factor}}$$

**Power Factor Measurements Go to Digital**

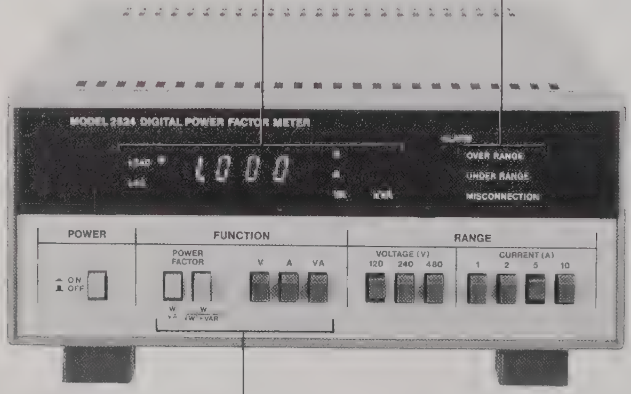
Conventional analog-type power factor meters measure power factor described in equation (1). At the push of a button, Model 2524 displays conventional power factor or true power factor described in equations (1) and (2). True rms measurement is especially valuable for the precision measurement of distorted, complex waves.

As an invaluable tool, Model 2524 can be used for every application including:

- For energy saving of electrical equipment and facilities, and power distribution lines (such as a way to improve power factor, and to lower power loss)
- For testing and checking of household appliances and electric instruments on the production line
- For experiment in laboratory and classroom
- For calibration of conventional power factor meters

## PANEL LAYOUT & FUNCTIONS

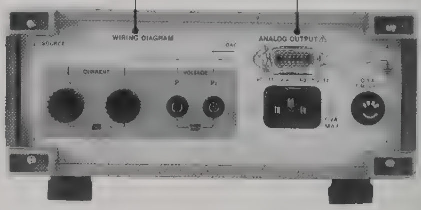
- **Data indication**
  Data . . . LED with max. reading of 1999.
  Power factor lamp . . . LEAD or LAG.
  Unit mark . . . V and A (basic functions), VA.kVA, W.kW or VAR.kVAR (optional function).
- **ALARM indicators**
  OVER RANGE & UNDER RANGE. . . Lights up when input exceeds approx. 120% or 40% of rated value.
  MISCONNECTION . . . Lights up when the input wiring on the rear panel is incorrect.



- **Function buttons**

*Front Panel (optional function . . . apparent power)*

- **Wiring diagram**
  Wiring of voltage and current input to terminals.
- **Analog output connector**
  Used for analog output and/or power factor measurement of 3-phase circuit.



*Rear Panel*

## SPECIFICATIONS

### GENERAL SPECIFICATIONS

**Type of Input:** Floating.

**Display:** Light-emitting diode (LED) display.

**Sample Rate:** Approx. 4 times per second.

**Maximum Reading:** 1999.

**Range Selection:** Manual.

**Function Selection:** Manual.

**Power Factor Lamp:** LEAD or LAG.

**Unit Marks:** V and A (basic functions), VA.kVA, W.kW, or VAR.kVAR (optional function).

**Effective Measuring Range:** 30 to 120% of input range (V and A), 50 to 120% of rated value (VA, W, VAR and power factor).

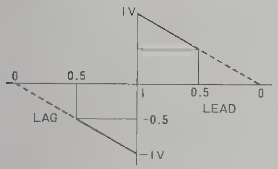
**Response Time:** Approx. 3 seconds (to reading within specified accuracy against input variations of from 50 to 100% of rated value, or from 100 to 50% of rated value).

**Operating Temperature Range:** 5 to 40°C (41 to 104°F).

**Humidity Range:** 20 to 80%, relative humidity.

**Warmup Time:** Approx. 30 minutes (to reading within specified accuracy).

**Analog Output:** Power factor . . . LEAD (1mV/digit), LAG (−1mV/digit).



V. . . 1.2V DC for rated input, A. . . 1.0V DC for rated input, VA. . . 1.2V DC for rated input.

Accuracy of output; Instrument accuracy ±5mV (at 1MΩ load).

Output impedance; Approx. 500Ω.

**Power Requirements:** 100, 110, 120, 200, 220, 230 or 240V AC (must be specified), 50 and 60Hz.

**Dielectric Strength:** 2,000V AC (50Hz) for one minute between input terminal and case, or between input and output terminals, 1,500V AC (50 Hz) for one minute between case and power line.

**Insulation Resistance:** More than 20 MΩ at 500V DC between input terminal and case, between input and output terminals, or between case and power line.

**Power Consumption:** Approx. 6VA.

**Dimensions:** Approx. 90 x 210 x 330mm (3-5/8 x 8-1/4 x 13").

**Weight:** Approx. 3.0kg (6.6 lbs).

**Accessories supplied at no extra cost:** Power cord (2- or 3-prong type) . . . 1 set, fuses (0.1A) . . . 2 pcs., output connector (AMPHENOL 57-30140). . . 1 pc., instruction manual . . . 1 copy.

**Ordering Information**

When ordering, please specify:

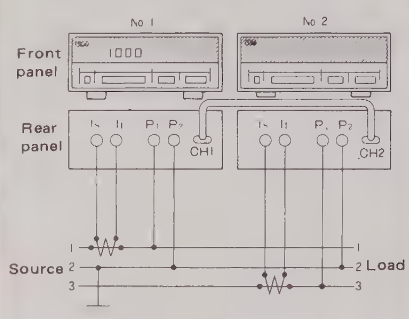
1. Instrument name, model number, and code.
2. Power supply voltage.

| **Measurement Function** | **STANDARD FUNCTIONS** | | | | **OPTIONAL FUNCTION** | | |
|---|---|---|---|---|---|---|---|
| | **POWER FACTOR** $\left(\frac{W}{Vrms\ Arms}\right)$ | **POWER FACTOR** $\left(\frac{W}{\sqrt{W^2+VAR^2}}\right)$ | **VOLTAGE(V)** | **CURRENT(A)** | **252400**<br>**Apparent Power (VA)** | **252410**<br>**Active Power (W)** | **252420**<br>**Reactive Power (VAR)** |
| **Rated Value (Input Ranges)** | 0.5 Lag—1.0—0.5 Lead | 0.5 Lag—1.0—0.5 Lead | 120, 240, 480V | 1, 2, 5, 10A | 120VA to 4.8kVA (V x A ranges) | 120W to 4.8kW (V x A ranges) | 120var to 4.8kvar (V x A ranges) |
| **Type of Input** | Corresponds to V and A measurements | | Potential transformer | Current transformer | Corresponds to V and A measurements | | |
| **Resolution** | 0.001/digit | 0.001/digit | 0.1V/digit | 1mA/digit | 0.1VA/digit | 0.1W/digit | 0.1var/digit |
| **Frequency Range** | 40 to 400Hz | 50 ±0.2Hz,<br>60 ±0.2Hz | 40 to 400Hz | | | | 50 ±0.2Hz,<br>60 ±0.2Hz |
| **Crest Factor** | Corresponds to V and A measurements | 1.4 (sine wave only) | Up to 2 | Up to 3 | Corresponds to V and A measurements | | |
| ***Accuracy** | Reading±0.015 for 47 to 63Hz, Reading±0.03 for 40 to 47Hz, and 63 to 400Hz<br>*Typical data*<br>Reading±0.05 for 20 to 500Hz, Reading±0.05 for Lead/Lag0.1—0.5 | Reading±0.015 | ±(0.5% of reading + 1 digit) for 47 to 63Hz, ±(1.5% of reading + 1 digit) for 40 to 47Hz, and 63 to 400Hz<br>*Typical data*<br>±(2.5% of reading + 2 digits) for 20 to 500Hz | | ±(1% of reading + 1 digit) for 47 to 63Hz, ±(3% of reading + 1 digit) for 40 to 47Hz, and 63 to 400Hz<br>*Typical data*<br>±(5% of reading + 2 digits) for 20 to 500Hz | | ±(0.5% of reading +1 digit) for sinϕ = 1 |
| **Temperature Coefficient** (at 5 to 20°C, or 26 to 40°C) | ±0.0005/°C | | ±0.05% of range/°C | | | | |
| **Volt-Ampere Loss** (approx. value, at 50Hz) | Corresponds to V and A measurements | | 0.05VA... 120V<br>0.2VA..... 240V<br>1.0VA..... 480V | 0.003VA.... 1A<br>0.02VA...... 2A<br>0.06VA...... 5A<br>0.3VA........10A | Corresponds to V and A measurements | | |
| **Max. Allowable Input** (continuous) | | | 2 x range (peak value) | 3 x range (peak value) | | | |
| **Max. Allowable Input** (for less than one second) | | | 3 x range (peak value) | 5 x range (peak value) | | | |
| **Common Mode Voltage Influence** | ±0.2% of range (at 50 or 60Hz, 1,000V applied between input terminal and case) | | | | | | |

*Note: At reference conditions of 23±3°C ambient temperature, sine wave input, power supply voltage fluctuation of within ±10% of rated value, 3-month calibration cycle.

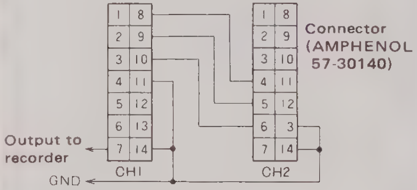
## POWER FACTOR MEASUREMENT OF 3-PHASE CIRCUITS

### 3-PHASE 3-WIRE CIRCUIT



*3-phase 3-wire circuit being measured*

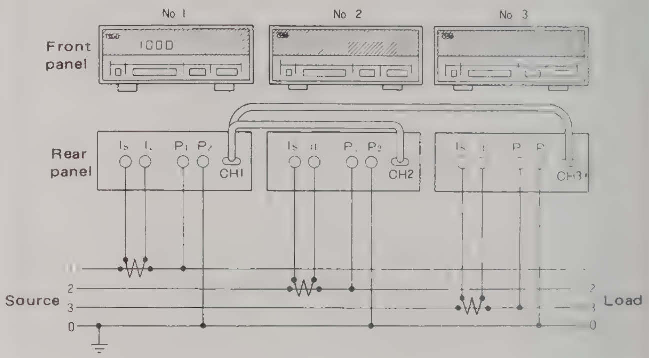
Notes: 1. Set models No. 1 and 2 to the same FUNCTION and RANGE.
2. There is possibility of MIS-CONNECTION lighting when the power factor lowers. The measurement and display are not affected by this lighting.



*Analog output connectors*

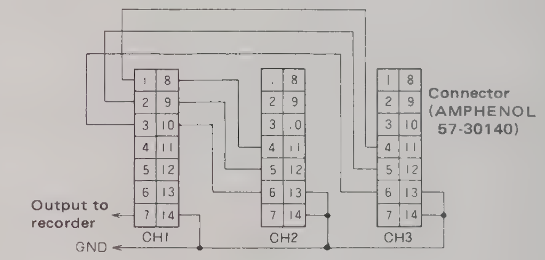
Note: Interconnection cable length should be shorter than 300mm.

### 3-PHASE 4-WIRE CIRCUIT



*3-phase 4-wire circuit being measured*

Note: Set models No. 1, 2 and 3 to the same FUNCTION and RANGE.



*Analog output connectors*

Note: Interconnection cable length should be shorter than 300mm.

YOKOGAWA ◆

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Represented by:

05

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# 2885
# Standard Watt Converter

## 0.02% Accuracy Using a Patented Time Division Multiplier

Type 2885 Standard Watt Converter converts AC power into DC output (1V and 5V) with an accuracy of ±0.02% of rated power. This makes the highest accuracy available on any wattmeter for commercial frequencies. Type 2885 can also be used as a precision digital wattmeter when combined with a digital voltmeter.

The instrument uses a "feedback time division multiplier" patented in both U.S.A. and Japan, and introduced in "IEEE Transactions on Instrumentation and Measurement".

As calibration or inspection standards, or as precision power measuring instruments, Type 2885's are now being used in major standard laboratories, institutes and industries throughout the world.

** U.S. Patent 3,500,109 (integrating alalog-to-digital converter usable in digital voltmeter)*

## MAIN FEATURES

- **0.02% accuracy**
- **Wide measuring range — 75 to 300V in 4 ranges, 0.5 to 20A in 6 ranges**
- **Frequency range from 30Hz to 3kHz**
- **High reliability**
  Type 2885 offers high reliability using a patented, solid-state multiplier and ICs in preference to conventional moving coils, thermocouples or mechanical choppers. The instrument is virtually unaffected by overload, tilt, vibration, and external magnetic field.
- **Fully isolated inputs and outputs**
  Dielectric withstand voltage is 2,000V AC for one minute between inputs and outputs, and between inputs, outputs, power line, case, and each other.
- **Auxiliary multiplier input**
  In addition to the standard voltage and current terminals, Type 2885 provides auxiliary input connectors to deliver full-scale output when 1V AC or DC is applied to the connectors.
  These connectors are suited for checking the multiplier by using an external DC source.

## SPECIFICATIONS

**Rated Input:** Voltage . . . 75, 100, 150, 300V AC, Current . . . 0.5, 1, 2, 5, 10, 20A AC.

**Output:** 1V or 5V DC, at rated power = (rated voltage) x (rated current) x (unity power factor).

**Frequency Range:** 30Hz to 3kHz.

**Accuracy:** ±0.02% of rated power, at (100V range) x (5A range), 47 to 63Hz, unity and/or zero power factor, ±0.05% of rated power, at (100V range) x (5A range), 63 to 400Hz, unity and/or zero power factor, Other input ranges . . . Add ±0.02% of rated power to the above accuracy.

*Above accuracies apply at the following reference standard conditions.*

Ambient temperature . . . 23±1°C, humidity range . . . 55±10% relative humidity, power supply voltage fluctuation . . . within ±1% of rated value, input . . . sine wave (distortion less than 0.3%).

(Typical data)
At (100V range) x (5A range), unity or zero power factor, % of rated power,
40Hz to 1kHz . . . ±0.1%, 20Hz to 2kHz . . . ±0.5%, 2 to 10kHz . . . ±1.5%.

**Long-Term Stability:** Better than 0.01%/3-month, better than 0.02%/6-month.

**Output Resistance:** 5V terminal . . . Less than 0.4Ω, maximum load 5mA, 0.05μF, 1V terminal . . . 800Ω.

**Maximum Allowable Input (for less than one second):** Voltage . . . 2 x rated voltage (peak value), Current . . . 5 x rated current (peak value).

**Maximum Allowable Input (Continuous):** Voltage . . . 1.5 x rated voltage (rms value) or 2 x rated voltage (peak value), whichever is lower, Current . . . 3 x rated current (rms value) or 5 x rated current (peak value), whichever is lower.

**Multiplier Input:** Rated input . . . 1V x 1V (DC, or 20Hz to 10kHz), output voltage . . . 1V or 5V DC, input resistance . . . approx. 3.33kΩ on X or Y side, allowable input . . . ±2V (peak value) on X side, ±5V (peak value) on Y side, accuracy (typical data, % of rated output), 47 to 63Hz . . . ±0.015%, DC, 63 to 400Hz . . . ±0.04%, 40Hz to 1kHz . . . ±0.07%, 20Hz to 2kHz . . . +0.4%, 2 to 10kHz . . . ±1%.

**Output Monitor Meter (% OUTPUT):** ±5V (x 1) or ±0.5V (x 10) selectable by METER SENSITIVITY button, zero-center black scale, meter indication accuracy . . . ±2% of full scale on 5V range, ±1.5% of full scale on 0.5V range.

**Residual Output:** 1mVrms, at rated input (30Hz), 5V output.

**Temperature Coefficient:** Zero point . . . ±0.01% of rated power/°C, full scale . . . ±0.005% of rated power/°C at 18 to 22°C, or 24 to 27°C, 100V. 5A range, 60Hz, unity power factor.

**Response Time:** Approx. 2 seconds (time required to attain a value within ±0.02% of final value).

**Input Voltage Impedance:**

| Range | Input impedance |
|---|---|
| 75V | Approx. 75kΩ/less than 18pF |
| 100V | Approx. 100kΩ/less than 13pF |
| 150V | Approx. 150kΩ/less than 8pF |
| 300V | Approx. 300kΩ/less than 8pF |

**Operating Temperature Range:** 18 to 27°C (64 to 81°F).

**Humidity Range:** 35 to 70% relative humidity.

**Warm-Up Time:** One hour.

**Input Current Burden:**

| Range | Burden |
|---|---|
| 0.5A | Approx. 0.05VA |
| 1A | Approx. 0.06VA |
| 2A | Approx. 0.1VA |
| 5A | Approx. 0.2VA |
| 10A | Approx. 0.3VA |
| 20A | Approx. 0.5VA |

**Power Requirements:** 100, 120, 200, 220 or 240V AC ±10% (must be specified), 47 to 63Hz.

**Power Consumption:** Approx. 20VA.

**Dielectric Strength:** 2,000V AC for one minute between voltage and current terminals, input and output terminals, input terminals and case, input terminals and power line, and output terminals and power line.

**Insulation Resistance:** More than 200MΩ at 500V DC between voltage and current terminals, input and output terminals, input terminals and case, input terminals and power line, and output terminals and power line.

**Dimensions:** Approx. 149 x 228 x 365mm (5-7/8 x 9 x 14-3/8″).

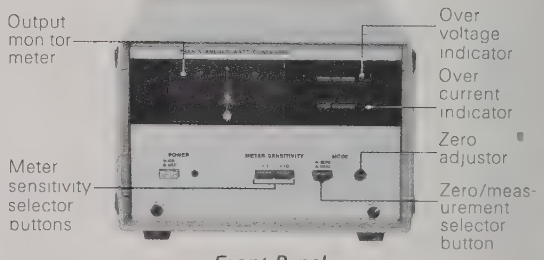
**Weight:** Approx. 8.5kg (18.7 lbs).

**Accessories supplied at no extra cost:** Fuses (0.5A) . . . 2 pcs.

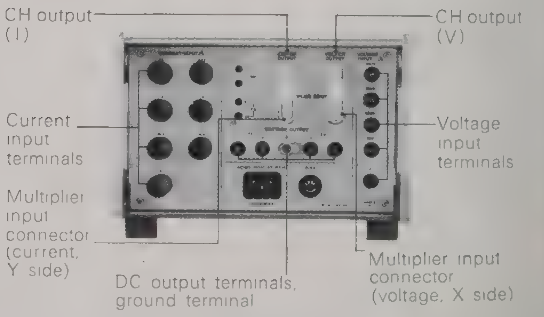
**Attached Document (Optional):** Test certificate by JEMIC (Japan Electric Meters Inspection Corporation) . . . 1 copy

**Type Number Designation:** **288520** . . . instrument only, **288521** . . . instrument with JEMIC test certificate.

## PANEL LAYOUT



*Front Panel*


CH output (I)
CH output (V)
Current input terminals
Voltage input terminals
Multiplier input connector (current, Y side)
DC output terminals, ground terminal
Multiplier input connector (voltage, X side)

*Rear Panel*

## FEEDBACK TIME DIVISION MULTIPLIER

Type 2885 uses a patented "Time Division Multiplier" which is a multiplying circuit based on the concept that the area of an electrical pulse is equal to the product of the pulse width and pulse height. A comparator compares output voltage $e_2$ of the integrator, in which the sum of input signal $E_X$ and standardized voltage $E_S$ is integrated with a 200 kHz sawtooth wave clock voltage. This controls the open/close ratio of switch $S_1$ so that the sum of input signal Ex and the DC mean value for a square wave of amplitude Es (which is determined by the operation of switch $S_1$) may be null. Consequently, if the time during which switch $S_1$ is connected to —Es is denoted by $T_1$ and that to +Es by $T_2$, the following formula holds, and a switch control signal whose pulse width is exactly proportional to the input signal $E_X$ is provided.

$$E_X/R_1 + (E_S/R_2)\ [(T_1 - T_2)/(T_1 + T_2)] = 0 \ldots (1)$$

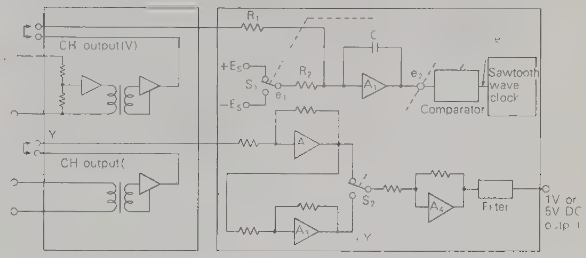
The other input signal $E_Y$ is switched with $S_2$, interlocked with $S_1$, giving a mean output:

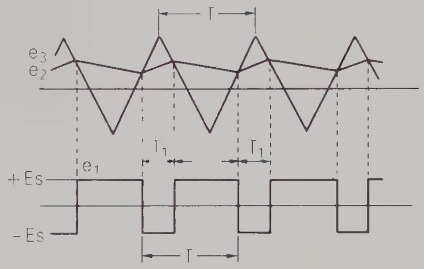
$$E\ out = E_Y\,(T_1 - T_2)/(T_1 + T_2) \ \ldots\ldots\ldots\ldots\ (2)$$

Thus, the output waveform has a pulse width proportional to input signal Ex, and pulse height proportional to input signal Ey. If $(T_1 - T_2)/(T_1 + T_2)$ is eliminated from (1) and (2),

$$E\ out = -(R_2/R_1)\,(Ex \cdot Ey)/Es \ \ldots\ldots\ldots\ldots\ldots\ (3)$$

Hence, the output is in proportion to the product to Ex and Ey.

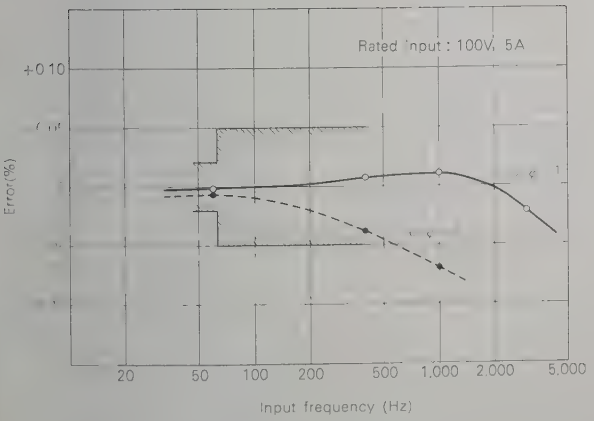




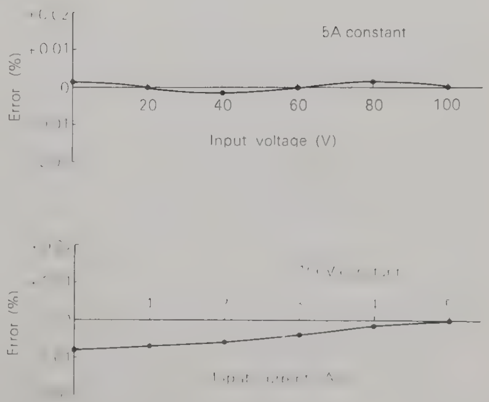
* *U.S. Patent 3,500,109 (Integrating analog-to-digital converter usable in digital voltmeter)*

* *Japanese Patent No. 533,437 & 560,971*

## CHARACTERISTICS CURVES



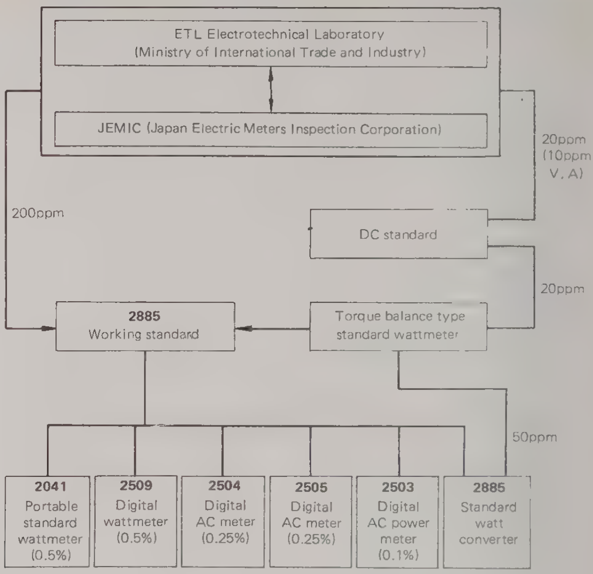
*Frequency characteristics (tested by JEMIC)*



*Linearity curves (100V, 5A, 60Hz)*

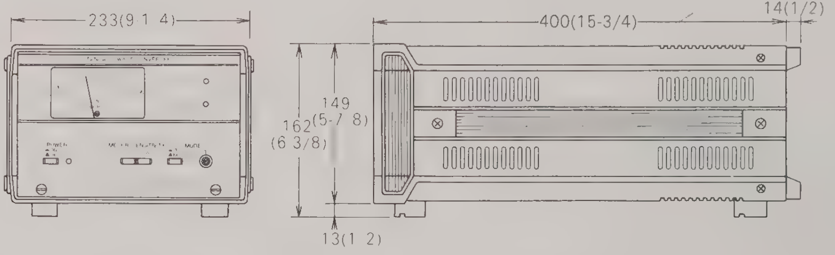
## TRACEABILITY AT YEW

Type 2885 is traceable to Japanese national standard, ETL, a representative organ in the international system of standardization. With an accuracy of 0.02%, Type 2885 is being used as a calibration working standard for power measuring instruments.


ETL Electrotechnical Laboratory
(Ministry of International Trade and Industry)
JEMIC (Japan Electric Meters Inspection Corporation)
20ppm (10ppm V, A)
200ppm
DC standard
20ppm
2885 Working standard
Torque balance type standard wattmeter
50ppm
2041 Portable standard wattmeter (0.5%)
2509 Digital wattmeter (0.5%)
2504 Digital AC meter (0.25%)
2505 Digital AC meter (0.25%)
2503 Digital AC power meter (0.1%)
2885 Standard watt converter

## DIMENSIONS

Unit: mm (approx. inch)



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12(YG) Printed in Japan

Bulletin

# 2655 & 2661
# DIGITAL MANOMETERS

High Accuracy and Stability Using a New Tuning Fork Pressure Sensor

Model 2661 [illegible]
Model 2655 [illegible]

YOKOGAWA

# Operates on power line/external 12V DC/Ni-Cd battery with key-selectable engineering units.

The Models 2655 and 2661 Digital Manometers are precision, high-resolution pressure measuring instruments which use a new tuning-fork pressure sensor. Using a new sensor and a microprocessor, Digital Manometers provide convenient and stable measurement with a full range of engineering units. Model 2661 is suitable for applications which require high-accuracy pressure measurement, and Model 2655, for general-purpose calibration, test and measurement.

## Common Features

- [illegible]
- [illegible]
- [illegible]gh stability with a new tuning fork pressure sensor. No gravity compensation required
- [illegible] selectable engineering units — including [illegible] kPa, mbar, inH O, mmHg, inHg and kg/cm
- [illegible] and easy zero adjustment
  Input connection of pressure is on the front, and zero adjustment is also possible from the front even with input pressure being applied to the instrument.
- [illegible] external 12V DC or rechargeable Ni-Cd battery [illegible]
- [illegible] horizontal or tilted operating [illegible]
- [illegible]
- [illegible] remote control (standard on 2661, optional on 2655)
- Compact and lightweight — weighs only 6 kg (13.2 lbs)

---

① **Mode indicator**

② **Digital display**

③ **Engineering units**

④ **POWER ON/OFF key**

⑤ **LOCAL key**

Depress to release remote control by GPIB (or RS-232C).

⑥ **DISPLAY ON/OFF key**

Select display ON/OFF under Ni-Cd battery operation. (On a single charge, operation lasts for about 6 hours if the key is ON and about 7 hours if OFF)

⑦ **DISPLAY HOLD key**

⑧ **UNIT key**

Engineering unit can be changed sequentially at a push of this key.

⑨ **CAL/OFFSET key**

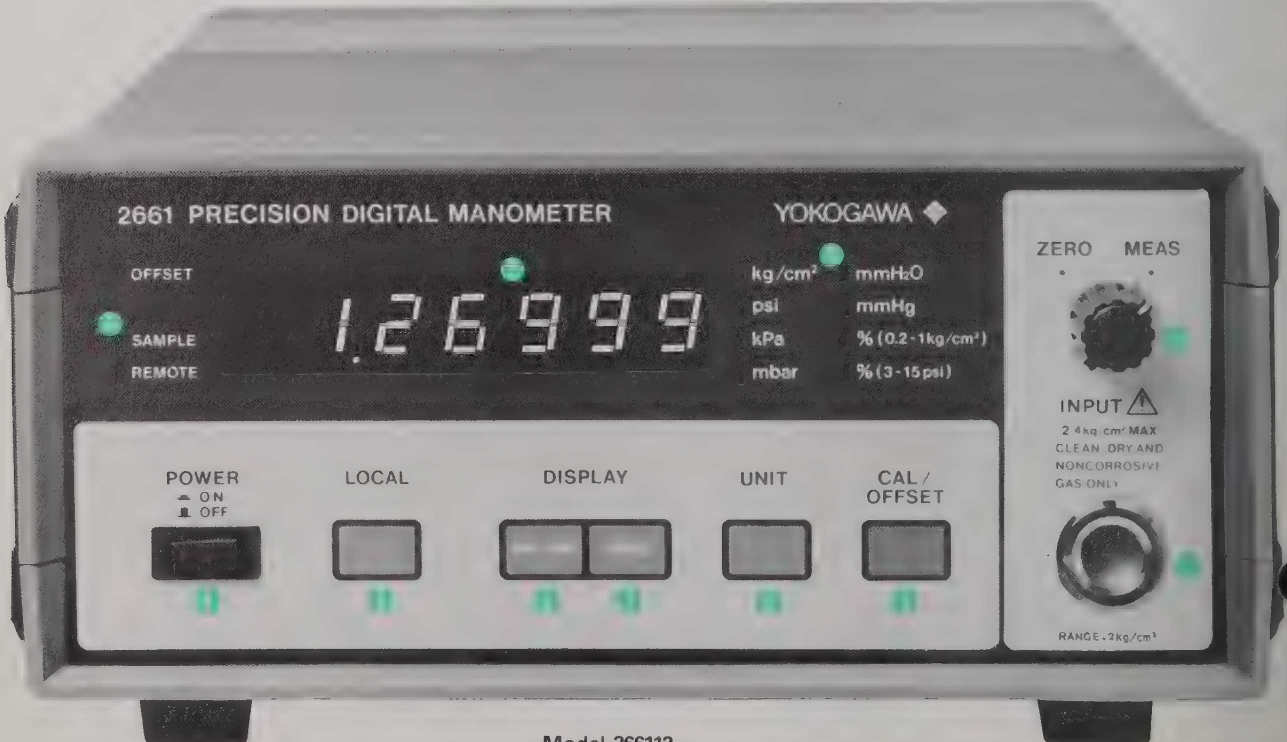
Used with ZERO/MEAS selector. OFFSET indicator lights up when OFFSET is selected.

⑩ **ZERO/MEAS selector**

Used with CAL/OFFSET key to adjust display at zero:

- ZERO-CAL ... Zero adjustment in relation to atmospheric pressure.
- MEAS-OFFSET ... Zero adjustment in relation to input pressure. (Continuous offset measurement of pressure is available after this adjustment)

⑪ **Pressure input connector**



Model 266112
(Metric model)

# Specifications

| Model | | 265511 | 265512 | 265522 | 265514 | 266111 | 266112 | 266122 |
|---|---|---|---|---|---|---|---|---|
| **Pressure Range (Full Scale)** | **Positive pressure** | 0 to 3 psi,<br>0 to 0.2 kg/cm$^2$ | 0 to 30 psi,<br>0 to 2 kg/cm$^2$ | | 0 to 30 psi abs.,<br>0 to 2 kg/cm$^2$ abs. | 0 to 3 psi,<br>0 to 0.2 kg/cm$^2$ | 0 to 30 psi,<br>0 to 2 kg/cm$^2$ | |
| | **Negative pressure** | 0 to −1.5 psi,<br>0 to −0.1 kg/cm$^2$ | 0 to −15 psi,<br>0 to −1 kg/cm$^2$ | | ——— | 0 to −1.5 psi,<br>0 to −0.1 kg/cm$^2$ | 0 to −15 psi,<br>0 to −1 kg/cm$^2$ | |
| **Accuracy** at ambient temperature of 23 ± 2°C, vertical operating position, hysteresis and linearity combined | **Positive pressure** | ±(0.04% of reading + 0.01% of full scale) | ±(0.03% of reading + 0.01% of full scale) | | ±0.05% of full scale | ±(0.01% of reading + 0.01% of full scale) | | |
| | **Negative pressure** | ±(0.4% of reading + 0.1% of full scale) | | | ——— | ±(0.4% of reading + 0.1% of full scale) | | |
| **Engineering Units** | | kg/cm$^2$, psi, kPa, mbar, mmHg, mmH$_2$O, inH$_2$O, inHg | kg/cm$^2$, psi, kPa, mbar, mmH$_2$O, mmHg, % of 0.2 to 1.0 kg/cm$^2$, % of 3 to 15 psi | psi, kPa, mbar, in H$_2$O, inHg, mmHg, % of 3 to 15 psi, kg/cm$^2$ | kg/cm$^2$, psi, kPa, mbar, mmHg, mmH$_2$O, inH$_2$O, inHg | | kg/cm$^2$, psi, kPa, mbar, mmH$_2$O, mmHg, % of 0.2 to 1.0 kg/cm$^2$, % of 3 to 15 psi | psi, kPa, mbar, inH$_2$O, inHg, mmHg, % of 3 to 15 psi, kg/cm$^2$ |
| **Pressure Connection** | | PT 1/4 (1/4 NPT, 1/8 NPT, PT 1/8 ...... optional) | | 1/4 NPT (1/8 NPT, PT 1/8 ...... optional) | PT 1/4 (1/4 NPT, 1/8 NPT, PT 1/8 ...... optional) | | | 1/4 NPT (1/8 NPT, PT 1/8 optional) |
| **Allowable Input Pressure** | **Positive pressure** | 3.4 psi or 0.24 kg/cm$^2$ | 34 psi or 2.4 kg/cm$^2$ | | 34 psi abs. or 2.4 kg/cm$^2$ abs. | 3.4 psi or 0.24 kg/cm$^2$ | 34 psi or 2.4 kg/cm$^2$ | |
| | **Negative pressure** | −1.5 psi or −0.10 kg/cm$^2$ | −15 psi or −1.0 kg/cm$^2$ | | ——— | −1.5 psi or −0.10 kg/cm$^2$ | −15 psi or −1.0 kg/cm$^2$ | |
| **Temperature Coefficient** at ambient temperature of 5 to 40°C | **Zero drift** | ±0.005% of full scale/°C, ±0.003% of full scale/°F (typical) | | | | ±0.001% of full scale/°C, ±0.0005% of full scale/°F | | |
| | **Sensitivity** | ±0.003% of full scale/°C, ±0.002% of full scale/°F (typical) | | | | ±0.001% of full scale/°C, ±0.0005% of ull scale/°F | | |
| **Atmospheric Pressure Effect** | | ±0.01% of full scale/5 mbar (typical) | | | ——— | ±0.001% of full scale/5 mbar | | |
| **Effect of Inclined Operating Position** at 90° inclined forward or backward, or 30° inclined right and left | | ±0.04% of full scale (90°)<br>±0.2% of full scale (30°) | ±0.04% of full scale (90°)<br>±0.02% of full scale (30°) | | | ±0.04% of full scale (90°)<br>±0.2% of full scale (30°) | ±0.04% of full scale (90°)<br>±0.02% of full scale (30°) | |
| **Fluid Leakage** | | Less than 1 cc/minute | | | Less than $10^{-5}$ cc/second | Less than 1 cc/minute | | |

Note: 265514 is zero adjusted by using an input of vacuum pump.

### General Specifications

**Pressure Sensing Element:** Tuning-fork pressure sensor and diaphragm (high-elasticity alloy EL-3).

**Applicable Fluids:** Clean, dry air or non-corrosive gases (fluid temperature should be within 5 to 50°C, or 41 to 122°F).

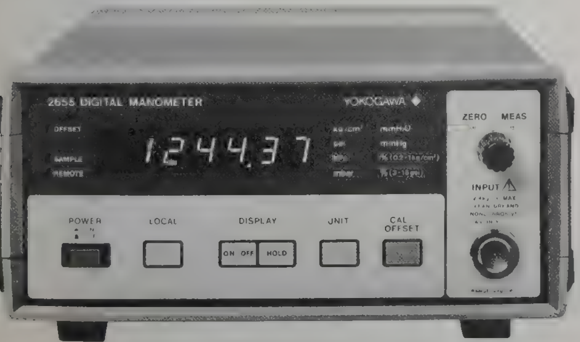
**Display:** 5-1/2-digit LED display (resolution . . . ±0.0005% of full scale).

**Sample Rate:** Approx. 0.4 s/sample.

**Response Time:** Approx. 2 s (display), approx. 0.6 s (analog output).

**Analog Output:** 2V DC for 30 psi or 2 kg/cm$^2$ input (0.4mV resolution), accuracy . . . ±(0.1% of full scale + 0.5mV), output impedance . . . 1Ω max., max. current . . . 3mA.

**Power Supply Fluctuation Effect:** No effect against ±10% AC power supply voltage or 10 to 15V DC variation, or 48 to 63 Hz power frequency variation.



**Model 265512 (Metric model)**

**Operating Temperature Range:** 5 to 40°C (41 to 104°F).

**Humidity Range:** 20 to 80% relative humidity.

**Warmup Time:** Approx. 30 minutes.

**Dielectric Strength:** 1,500V AC for one minute between power line and case.

**Insulation Resistance:** More than 20MΩ at 500V DC between power line and case.

**Power Requirements:** 100, 115, 200 or 230V AC (must be specified), 50 and 60Hz, 10 to 15V DC, and rechargeable Ni-Cd battery (self-contained, continuously operates about six hours on a single charge).

**Power Consumption:** Approx. 20 VA max.

**Dimensions:** Approx. 112 x 233 x 364 mm (4-3/8 x 9-1/4 x 14-3/8").

**Weight:** Approx. 6 kg (13.2 lbs) includes battery, or approx. 6.2 kg (13.7 lbs) with GPIB or RS-232C interface.

**Accessories supplied at no extra cost:** Input connector ... 1 pc., fuse (0.3A or 0.5A) ... 1 pc., Ni-Cd battery ... 1 pc., DC source connector ... 1 pc., power cord ... 1 set, instruction manual ... 1 copy.

■ GPIB Interface (Standard on 2661, Optional on 2655)

**Functional, Electrical and Mechanical Specifications:** Meets IEEE Standard 488-1978 "Digital Interface for Programmable Instrumentation".

**Interface Function and Identification:** SH1, AH1, T5, L4, SR1, PP0, DC1, DT1, C0 (Talker & Listener, Talk only).

■ RS-232C Interface (Standard on 2661, Optional on 2655)

**Functional Specifications:** Hardware/software handshaking, synchronous (data transfer rates... 75, 150, 300, 600, 1,200, 2,400, 4,800, 9,600 bits/s).

## Examples of Applications

**Model 2661**

- Pressure standard in R & D
- Working pressure standard for high-precision pressure instruments (differential pressure transmitters, pneumtic pressure transmitters, and similar pneumatic process instruments)
- Precision pressure tests and measurements such as wind tunnel tests, performance tests of turbines, pumps and fans

**Model 2655**

- Calibration of pressure instruments (differential pressure transmitters, pneumatic pressure transmitters, and similar pneumatic process instruments)
- Test and measurement of pneumatic instruments and devices

## Pressure Sensing Element

Models 2655 and 2661 use a new pressure sensing element, a tuning-fork pressure sensor. This new element measures input pressure as a change in frequency, providing high stability and resolution.

Figure 1 is a tuning-fork pressure sensor consisting of a pair of forks. When force is applied in an axial direction, the natural frequency of the forks changes. Therefore, the applied force can be found by measuring the natural frequency with piezoelectric elements. Figure 2 shows the construction of a pressure sensing element using a tuning-fork pressure sensor. The upper bushing of the sensor is welded directly to the diaphragm, and the lower bushing to the element body. When pressure is applied to the diaphragm, compression force acts on the sensor. Then, the natural frequency is measured through a self-excitation circuit, which consists of a pair of piezoelectric elements (one for excitation and another for detection).

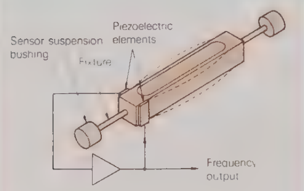


**Fig. 1 Tuning-fork pressure sensor**

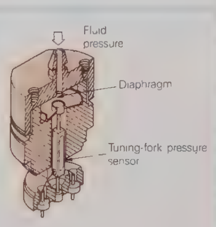
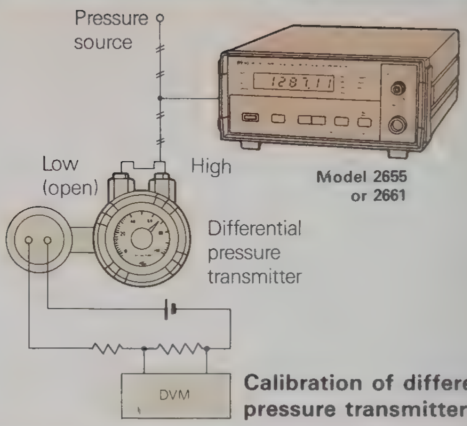


**Fig. 2 Cutaway view of pressure sensing element**

### Spare for 2655 & 2661

| Name | Part No. | Description |
|---|---|---|
| Ni-Cd battery | **A9042ED** | 1 pc |



**Calibration of differential pressure transmitter**

### Available Models

| Name | Model | Pressure Range | Unit *(Connection) |
|---|---|---|---|
| Digital manometer | **265511** | 3 psi, 0.2 kg/cm$^2$ (gauge) | Metric & Inch *(PT 1/4) |
| | **265512** | 30 psi, 2 kg/cm$^2$ (gauge) | Metric *(PT 1/4) |
| | **265522** | 30 psi, 2 kg/cm$^2$ (gauge) | Inch *(1/4 NPT) |
| | **265514** | 30 psi, 2 kg/cm$^2$ (absolute) | Metric & Inch *(PT 1/4) |
| Precision digital manometer | **266111** | 3 psi, 0.2 kg/cm$^2$ (gauge) | Metric & Inch *(PT 1/4) |
| | **266112** | 30 psi, 2 kg/cm$^2$ (gauge) | Metric *(PT 1/4) |
| | **266122** | 30 psi, 2 kg/cm$^2$ (gauge) | Inch *(1/4 NPT) |

*Note: Specify pressure connection of other than above.
(Refer to Optional Feature)

### Optional Features

| Option Code | Name | Compatible Models |
|---|---|---|
| **/GP-IB** | GPIB interface | **2655** |
| **/RS232C** | RS-232-C interface | **2655, 2661** |
| **/NPT4** | 1/4 NPT pressure connection | |
| **/NPT8** | 1/8 NPT pressure connection | |
| **/PT8** | PT 1/8 pressure connection | |

Notes: 1) Both GPIB and RS-232-C are not compatible with a single unit
2) The following models are also available upon request
- The model of rear-panel pressure connection.
- The model with panel mount adapter.

### Optional Accessory for 2655 & 2661

| Name | Part No. | Description |
|---|---|---|
| Pressure input connector | **B9310ZH** | Low-leakage, quick change type, 1 pc. (PT 1/4 male) |

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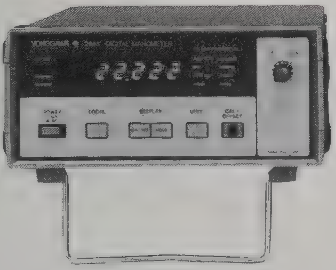
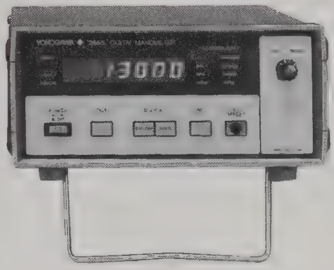
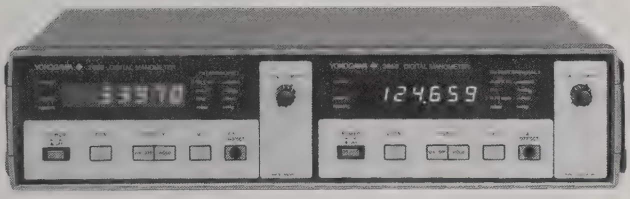
# 2655 14S DIGITAL MANOMETERS (FOR AIRCRAFT APPLICATION)
## for Altimeter and Airspeed Indicator Calibration

High Accuracy and Stability Using a Tuning-Fork Pressure Sensor


Model 2655 14S4
(for airspeed indicator calibration)


Model 2655 14S3
(for altimeter calibration)


Model 2655 14S5
(for altimeter and airspeed indicator calibration)

Useful for Calibration of Altimeters and Airspeed Indicators in Test Rooms

Intelligent models with seven pressure units in addition to altitude or air speed unit.

Developed for easy calibration of aircraft altimeters and airspeed indicators, the Models 265514S3 (absolute pressure) and 265514S4 (differential pressure) are precision, high-resolution digital manometers which use a new tuning-fork pressure sensor. Both models provide highly-stable pressure measurement with altitude or air speed units, and a full range of pressure engineering units.

**Available Models**

| Model | Application | |
|---|---|---|
| 2655 14S3 | For altimeter | -1,000 to 80,000 ft |
| 2655 14S4 | For airspeed indicator | 0 to 800 knots |
| 2655 14S5 | 2655 14S3 + 2655 14S4 | |

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## Features

- High Stability
  Least affected by temperature, tilting, and vibration.
- Key-Selectable 7 Pressure Units
  Model 2655 14S3 ... psiA, kPa, mbar, mm $H_2O$, mm Hg, in $H_2O$, and in Hg.
  Model 2655 14S4 ... psi, A/S mph (air speed : miles/h), mbar, mm $H_2O$, mm Hg, in $H_2O$, and in Hg.
- Analog Output and GPIB or RS-232C Interface
  By connecting a personal computer or a recorder, recording of pressure changes, tabulating and analysis of pressure data are available.
  GPIB or RS-232C Interface ....... Optional
  Analog Output .................. Standard
- Compact and Lightweight
  Weighs only about 5 kg (11 lbs). Easy to transport. Can be used in either vertical or horizontal positions.
- Three-way Power System
  Can be operated from 12 V DC source, Ni-Cd battery (optional) or AC line.

## General Specifications

Display : 5-1/2-digit LED display (overrange ...up to +20% of F.S.).

Resolution : 0.005% of F.S. (except for ALT FT, A/S KTS and A/S mph).
ALT FT... 1 ft for -1,000 to 37,000 ft.
2 to 8 ft for 37,000 to 80,000 ft.
A/S KTS.. 1 knot for 0 to 40 knots.
0.1 knot for 40 to 300 knots.
0.01 knot for 300 to 800 knots.

Pressure Sensor : Composite tuning-fork sensor.

Pressure Sensing Element: Diaphragm (constant elasticity alloy EL-3).

Measuring Fluid : Air or gases (non-corrosive, 5 to 50°C or 41 to 122°F).

Pressure Connection : NPT 1/4 female (standard),
PT 1/8, PT 1/4 or NPT 1/8 (optional, must be specified).
PVC tube (ID 4 mm, OD 6 mm, with connector).

Sample Rate : 0.8 s.

Response Time : Approx. 2 s (display), Approx. 0.6 s (analog output).

Analog output : 1 mV/100 digits (0.8 V DC at 80,000 ft).
(Standard) Resolution ... 0.4 mV. Sample rate ... 0.8 s.
Accuracy ... ±(0.1% of F.S. + 0.5 mV). Output resistance ... 1 Ω max., Max. allowable current ... 3 mA.

Operating Temperature Range: 5 to 40°C (41 to 104°F).

Operating Humidity : 20 to 80% R.H.

Warmup Time : Approx. 30 minutes.

Power Requirements : 3-way power system;
115 V AC ± 10%, 50/60 Hz, 10 to 15 V DC, or Ni-Cd battery (optional).
100, 200, or 230 V AC is also available (must be specified).

## Specifications

| Name | Digital Manometer (for Aircraft Application) | | | |
|---|---|---|---|---|
| Model | 2655 14S3 | | 2655 14S4 | |
| Application | Altimeter calibration<br>absolute pressure | | Airspeed indicator calibration<br>differential pressure (P1 - P2) | |
| Calibration/ Measuring Range (F.S.) | ALT FT | -1,000 to 80,000 ft | A/S KTS | 0 to 800 knots |
| | psiA | 0 to 28.4 psi(abs) | psi | 0 to 28.4 psi(abs) |
| | kPa | 0 to 196.1 kPa(abs) | A/S mph | 0 to 920 miles/h |
| | mbar | 0 to 1,961 mbar(abs) | mbar | 0 to 1,961 mbar(abs) |
| | mm $H_2O$ | 0 to 20,000 mm $H_2O$ (abs) | mm $H_2O$ | 0 to 20,000 mm $H_2O$ (abs) |
| | mm Hg | 0 to 1,471 mm Hg (abs) | mm Hg | 0 to 1,471 mm Hg(abs) |
| | in $H_2O$ | 0 to 787 in $H_2O$ (abs) | in $H_2O$ | 0 to 787 in $H_2O$(abs) |
| | in Hg | 0 to 57.9 in Hg (abs) | in Hg | 0 to 57.9 in Hg(abs) |
| Measuring Accuracy | ALT FT : ±(0.13% of rdg + 0.05% of F.S.)<br>Other ranges: ± 0.05% of F.S. | | A/S KTS, A/S mph : ±(0.13% of rdg + 0.05% of F.S.)<br>Other ranges: ± 0.05% of F.S. | |
| Max. Allowable Input | 34.1 psi (abs) (equivalent to 2.4 kg/cm$^2$ abs) for all ranges | | | |
| Temperature Effect | (Typical)<br>Zero drift : ±0.005% of F.S./°C<br>Span : ±0.003% of F.S./°C | | | |
| Tilting Error | ± 0.04% of F.S. (90° forward or backward from vertical)<br>± 0.02% of F.S. (30° rightward or leftward from horizontal) | | | |
| Fluid Leakage | 5 x $10^{-6}$ cc/second | | | |

Power Supply Fluctuation Effect : No effect against ± 10% AC supply voltage or 10 to 15 V DC variation, or 48 to 63 Hz frequency variation.

Insulation Resistance : More than 20 MΩ at 500 V DC between power line and case.

Dielectric Strength: 1,500 V AC for one minute between power line and case.

Power Consumption : Approx. 20 VA max.

Ni-Cd Battery (Optional) : Continuous operating time .... about six hours on a single charge.

External Dimensions : Approx. 112 (H) x 233 (W) x 364 (D) mm (4-3/8 x 9-1/4 x 14-3/8 ").

Weight : Approx. 5 kg (11 lbs) (approx. 5.2 kg, 11.5 lbs, for the model with GPIB or RS-232C interface).

Accessories supplied at no extra cost:
Power cord ... 1 set, Fuse ... 1 pc (0.5 A for 115 V system, or 0.3 A for 200 V system), DC source connector ... 1 pc, Instruction manual ... 1 copy.

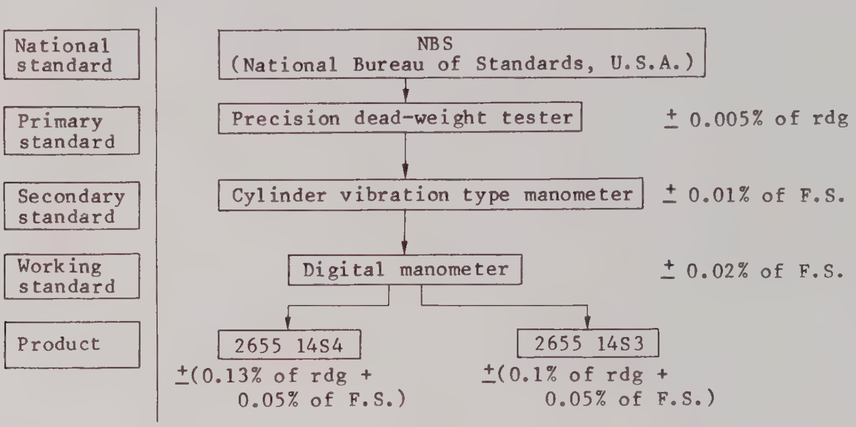
GPIB Interface (Optional)
Electrical and Mechanical Specifications : Meets IEEE St'd 488-1978.
Functional Specifications : SH1, AH1, T5, L4, SR1, RL1, PP0, DC1, DT1, C0 (Talker & Listener, Talk Only)

RS-232C Interface (Optional)

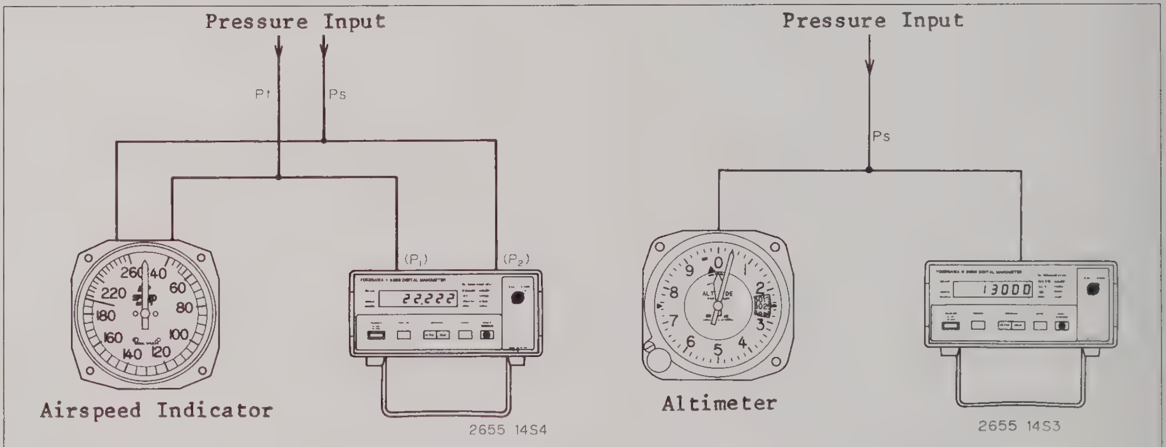
Transmission Method : Start/stop system (synchronous).

Data Transfer Rates : 75, 150, 300, 600, 1,200, 2,400, 4,800, or 9,600 bits/s.

## Traceability of Digital Manometer


National standard
Primary standard
Secondary standard
Working standard
Product
NBS (National Bureau of Standards, U.S.A.)
Precision dead-weight tester
± 0.005% of rdg
Cylinder vibration type manometer
± 0.01% of F.S.
Digital manometer
± 0.02% of F.S.
2655 14S4
±(0.13% of rdg + 0.05% of F.S.)
2655 14S3
±(0.1% of rdg + 0.05% of F.S.)

## Examples of Applications



Calibration of Airspeed Indicator

Calibration of Altimeter

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# 2654 Digital Manometers
# 2656 Pneumatic Pressure Standards

## 2654 DIGITAL MANOMETERS

*265423*

The Type 2654 Digital Manometers are easy-to-handle 5-digit pressure indicators which measure pressures with an accuracy of ±0.1% or ±0.2% and response time of two seconds. In contrast to general-use mercury or water column manometers, Type 2654 completely eliminates such inconveniences as fragile construction, restriction on operating position, troublesome mercury handling, compensation for ambient temperature and gravity, and others.

Input pressure is measured by a stable pneumatic-to-voltage converter and converted into digital signal through an analog-to-digital converter based on the YEW-patented "integrating type feedback pulse width modulation counting method".

### COMMON FEATURES

- **±0.1% or ±0.2% Accuracy**
  Input pressure is measured with ±0.1% or ±0.2% accuracy at 23±3°C, comparable with those of general-use mercury and water column manometers. Other excellent performance include the temperature drift of ±0.1% or ±0.2% of full scale/10°C, two-second response time.
- **Quick, Easy Pushbutton Operation and Zero Adjustment**
  Zero adjustment is possible from the front even with input pressure being applied to the instrument.
- **No Temperature and Gravity Compensations Required**
- **Power Line/Rechargeable Ni-Cd Battery Operation (Standard)**
- **Linear Analog Output (Standard)**
- **Negative Pressure Measurement**
  Useful for pressure absorption test and inspection of diverse types of equipment and appliances such as process and pressure control instrument, electric fan, cleaner, electrical pump.
- **Horizontal, Vertical or Tilted Operating Position**
- **Stable Pneumatic-to-Voltage Converter and A-D Converter**

## SPECIFICATIONS OF 2654

**Operating Principle:** Bellows pressure sensor, differential transformer (inductance) and integrating type analog-to-digital converter based on teedback pulse width modulation counting method, (non-explosion-proof construction).

**Pressure Sensing Element:** Phosphor-bronze or stainless steel bellows.

**Pressure Connection:** JIS PT 1/4 (or 1/4 NPT) female provided on the rear panel.

**Display:** LED (light-emitting diode) display.

**Maximum Reading:** 11900.

**Sample Rate:** Approx. 1.5 times/second (approx. 0.6 second/sample) and HOLD.

**Response Time:** (Time for attaining a value within a specified accuracy) Approx. 2 seconds for display, or 20 milliseconds for analog output.

**Analog Output (Standard):** +5 V DC for rated input pressure,
Accuracy: ±0.1% of full scale, Output impedance: 1Ω, Max, current: 3 mA.

**Operating Temperature Range:** 5 to 40°C (41 to 104°F).

**Humidity Range:** 20 to 80% (relative humidity).

**Warmup Time:** Approx. 30 minutes.

**Power Supply Voltage:** 100, 115, 200, 215 or 230V AC ± 10V, 50 or 60 Hz (must be specified), or 12 V DC (built-in rechargeable Ni-Cd battery of continuous five hours operation).

**Effect of Power Supply Voltage Variation:** ±0.01% of full scale against ±10% power supply voltage variation.

**Dielectric Strength:** 1,500V AC for one minute between power line and case.

**Insulation Resistance:** More than 100 MΩ at 500V DC.

**Power Consumption:** Approx. 12VA.

**Dimensions:** Approx. 149 x 233 x 364 mm (5-7/8 x 9-1/4 x 14-3/8").

**Weight:** Approx. 9.5 kg (20.9 lbs) with battery.

**Accessories furnished at no extra cost:**
Rechargeable Ni-Cd battery . . . 1 pc., Power cord (2- or 3-prong type) . . . 1 set, Fuses (1 A) . . . 2 pcs., Input connector . . . 1 pc. (excludes for 265421, 265422)

| Code | | 265421 | 265422 | 265423 | 265424 | 265425 | 265426 |
|---|---|---|---|---|---|---|---|
| **Range Selector** | | 10 kg/cm$^2$,<br>20 kg/cm$^2$ | 5 kg/cm$^2$<br>10 kg/cm$^2$ | 1, 2 kg/cm$^2$<br>1,000 mmHg,<br>% of 0.2 to 1 kg/cm$^2$ | 1,000 mmH$_2$O,<br>2,500 mmH$_2$O | 250 mmH$_2$O,<br>500 mmH$_2$O | 1 kg/cm$^2$ abs.,<br>2 kg/cm$^2$ abs.,<br>1,000 mmHg abs. |
| **Pressure Range (Full Scale)** at mercury temperature of 0°C (mmHg), or at water temperature of 4°C (mmH$_2$O) | | 0 to 10.000 kg/cm$^2$,<br>0 to 20.00 kg/cm$^2$ | 0 to 5.000 kg/cm$^2$<br>0 to 10.000 kg/cm$^2$ | 0 to ±1.0000 kg/cm$^2$,<br>0 to 2.000 kg/cm$^2$,<br>0 to 1,000.0 mmHg,<br>0 to 100.00% | 0 to ±1,000.0 mmH$_2$O,<br>0 to ±2,500 mmH$_2$O | 0 to ±250.0 mmH$_2$O,<br>0 to ±500.0 mmH$_2$O | 0 to 1.0000 kg/cm$^2$ abs.,<br>0 to 2.000 kg/cm$^2$ abs.,<br>0 to 1,000.0 mmHg abs. |
| **Applicable Fluids** | | Clean, dry air, non-corrosive gases, or non-corrosive liquids compatible with stainless steel (JIS SUS 316L, equivalent to AISI 316L) bellows. Fluid temperature should be within 5 to 50°C. | | Clean, dry air or non-corrosive gases compatible with phosphor bronze bellow. Fluid temperature should be within 5 to 50°C. | | | |
| **Overrange** | | Approx. 20% overrange possible on all ranges (numeric display flickers when overloaded) | | | | | |
| **Allowable Input Pressure** | | 24 kg/cm$^2$ | 12 kg/cm$^2$ | 2.4 or −1.0 kg/cm$^2$ | ±3,000 mmH$_2$O | ±600 mmH$_2$O | 2.4 kg/cm$^2$ abs. |
| **Unit Marks** | | kg/cm$^2$ | kg/cm$^2$ | kg/cm$^2$, mmHg, % | mmH$_2$O | mmH$_2$O | kg/cm$^2$, mmHg |
| **Polarity** | | — | | Negative sign (—) displayed in negative pressure measurement | | | — |
| **Accuracy** (at ambient temperature of 23±3°C, hysteresis and linearity combined) | **Positive pressure** | ±0.1% of full scale | ±0.1% of full scale | ±0.1% of full scale | ±0.1% of full scale | ±0.2% of full scale | ±0.1% of full scale after zero check,<br>±0.3% of full scale without zero check |
| | **Negative pressure** | — | — | ±0.5% of full scale | ±0.5% of full scale on 1,000 mmH$_2$O range,<br>±1.0% of full scale on 2,500 mmH$_2$O range | ±0.5% of full scale on 250 mmH$_2$O range,<br>±1.0% of full scale on 500 mmH$_2$O range | — |
| **Temperature Coefficient** (at ambient temperature of 5 to 40°C) | **Zero drift** | ±0.1% of full scale/10°C | | ±0.1% of full scale/10°C | ±0.2% of full scale/10°C | ±0.2% of full scale/10°C | ±0.1% of full scale/10°C |
| | **Full scale stability** | ±0.5% of full scale/10°C | ±0.1% of full scale/10°C | ±0.1% of full scale/10°C | ±0.1% of full scale/10°C | ±0.2% of full scale/10°C | ±0.1% of full scale/10°C |
| **Effect of Inclined Operating Position** (at 0 to 90° inclined forward or backward, or 0 to 30° inclined right and left, for zero drift only) | | ±0.5% of full scale | | ±0.1% of full scale | ±0.2% of full scale | ±0.5% of full scale | ±0.1% of full scale |
| **Fluid Leakage** | | 10$^{-5}$ cc per second | | 5 cc per minute | | | 10$^{-5}$ cc per second |

The models with other pressure ranges than above are available upon request.
Examples
- * 100, 200 kPa, 1,000mmHg, % of 20 to 100 kPa.
- * 10, 25 kPa.
- * 1, 2 bar, 1,000mmHg, % of 0.2 to 1 bar.
- * 100, 250 mbar.
- * 25, 50 mbar.
- * 15, 30 PSI, 1,000mmHg, % of 3 to 15 PSI.

# 2656 PNEUMATIC PRESSURE STANDARDS

The YEW Type 2656 pneumatic pressure standards are invaluable, time-saving tools for calibration or testing of pressure-related instruments and devices, including pressure gauges, transducers, and production pressure instruments. They are also suitable for applications which require maintaining constant pressure in a process or experiment.

Pressure of within 0.1% accuracy is easily available through the simple, speedy operation of four decade dials and pushbuttons. Type 2656 is small, portable and easily operated even by untrained personnel. The instrument weights 9.3kg, measures 149mm high, 228mm wide and 415mm deep.

*265624*

## MAIN FEATURES

- **Choice of two models—0 to 2 kg/cm$^2$ and 0 to 200 kPa, or 0 to 2,500 mmH$_2$O and 0 to 25 kPa**
- **±0.1% accuracy**
  Accuracy of output pressure is within ±0.1% of setting, or ±0.05% of full scale (whichever is greater) on all ranges.
- **OUTPUT DIVIDER dial for 20% or 25% increment output pressure setting**
  Two modes are available:
  - 20% increments in 5 steps . . . 0, 20, 40, 60, 80 or 100% of output pressure setting,
  - 25% increments in 4 steps . . . 0, 25, 50, 75 or 100% of output pressure setting.
- **VERNIER dial**
  For manual fine output pressure control or direct readout of percentage deviation of test point.
- **OFFSET meter**
  The pointer indication of within green scale stands for in-spec pressure supply.
- **Exact setting and readout by in-line digital display**
- **Quick, simple pushbutton and dial operation**
- **Fast response**
  After dial setting, desired pressure within specified accuracy is available in about 3 seconds without overshooting (at load capacity of less than 100 cc).
- **Stable pneumatic-to-voltage converter and servo-controlled pressure regulator**
- **Standard analog output**
- **Unaffected by tilt**
- **Compact and lightweight — portable 9.3 kg**

## GENERAL SPECIFICATIONS

**Composition:** Bellows pressure sensor, differential (inductance) transformer, digital-to-analog converter based on pulse width modulation method, and servo-controlled pressure regulator.

**Pressure Sensing Element:** Phosphor-bronze bellows.

**Source Pressure:** Clean, dry air. Air temperature of within 5 to 45°C (an external regulator with filter is recommended to use with Type 2656).

**Input and Output Pressure Connections:** JIS PT 1/4 female provided on the rear panel.

**Response Time:** (Time for attaining a value within specified accuracy), approx. 3 seconds at any of 20% or 25% increment setting, and load capacity of less than 100 cc.

**Calibration Interval:** 3 months.

**Air Consumption:** Approx. 1.8 m$^3$/h.

**Operating Temperature Range:** 5 to 45°C (41 to 113°F).

**Humidity Range:** 5 to 95% relative humidity.

**Warmup Time:** Approx. 30 minutes.

**Input Requirements (Electrical):** 100, 120, 200, 220 or 240V AC± 10% (must be specified), 50 and 60Hz.

**Dielectric Strength:** 1,500V AC for one minute between power line and case.

**Insulation Resistance:** More than 100MΩ at 500V DC

**Power Consumption:** Approx. 30VA.

**Dimensions:** Approx. 149 x 233 x 414mm (5-7/8 x 9-1/4 x 16-3/8").

**Weight:** Approx. 9.3kg (20.5 lbs).

**Accessories supplied at no extra cost:**
Power cord (2- or 3-prong type) . . . 1 set, fuses . . . 2 pcs., input connectors . . . 2 pcs., output connectors . . . 2 pcs.

## SPECIFICATIONS OF 2656

| Code | | 265623 | 265624 |
|---|---|---|---|
| **Output Pressure Range (Full Scale)** | | 0 to 2.0000 kg/cm², 0 to 200.00 kPa | 0 to 2500.0 mmH$_2$O, 0 to 25.000 kPa |
| **Overrange Output Pressure** | | Approx. 20% overrange output pressure available without specified accuracy | |
| **Input Requirements (Pressure)** | | 2.8 ± 0.2 kg/cm² | 0.5 ± 0.1 kg/cm² |
| **Maximum Resolution of Output Pressure Setting** | | ± 0.0001 kg/cm², ± 0.01 kPa | ± 0.1 mmH$_2$O, ± 0.001 kPa |
| **Accuracy of Output Pressure** (at an ambient temperature of 23 ± 3°C) | | ± 0.05% of full scale, or ± 0.1% of setting (whichever is greater) | |
| **Output Noise** | | ± 0.02% of full scale | ± 0.02% of full scale |
| **Pressure RANGE Selectors** | | kg/cm² or kPa | mmH$_2$O or kPa |
| **Output Pressure Setting** | | By 4 decade dials (max. setting . . . 2000) | By 4 decade dials (max. setting . . . 2500) |
| **OUTPUT DIVIDER Setting** | | Output pressure can be set to the following 20% or 25% increments by operation of OUTPUT DIVIDER dial:<br>20% increments in 5 steps . . . 0, 20, 40, 60, 80 or 100% of output pressure setting.<br>25% increments in 4 steps . . . 0, 25, 50, 75 or 100% of output pressure setting. | |
| **VERNIER Control** (manual fine output pressure control) | | * 0 to ± 1 x $10^{-3}$ kg/cm² output (± 1 x $10^{-4}$ kg/cm² resolution)<br>* 0 to ± 0.1 kPa output (± 0.01 kPa resolution)<br>* % of span output: 0 to ± 1% of output pressure setting . . . DIVIDER set at 25% increments in 4 steps, or 0 to ± 0.8% of output pressure setting . . . DIVIDER set at 20% increments in 5 steps (resolution: ± 0.025% of output pressure setting) | * 0 to ± 1 mmH$_2$O output (± 0.1 mmH$_2$O resolution)<br>* 0 to ± 1 x $10^{-2}$ kPa output (± 1 x $10^{-3}$ kPa resolution)<br>* % of span output: 0 to ± 1% of output pressure setting |
| **Temperature Coefficient of Output** (at an ambient temperature of 5 to 45°C) | **Zero drift** | ± 0.0001 kg/cm²/°C | ± 0.1 mmH$_2$O/°C |
| | **Sensitivity** | ± 0.01% of output pressure setting/°C | ± 0.01% of output pressure setting/°C |
| **Tilt Sensitivity** (at 90° tilted forward or backward, or 30° tilted right or left, for zero drift only) | | ± 0.001 kg/cm² | ± 5 mm H$_2$O |
| **Analog Output (Standard)** | | 0 to 10mV DC for 0 to 2 kg/cm² output setting (accuracy . . . ± 0.05% of F.S.), output impedance . . . less than 100Ω, max. current . . . 5mA | 0 to 10mV DC for 0 to 2500 mmH$_2$O output setting (accuracy . . . ± 0.05% of F.S.), output impedance . . . less than 100Ω, max. current . . . 5mA |
| **Effect of Power Supply Voltage Fluctuations** | | Within ± 0.0001 kg/cm² for ± 10% power supply voltage fluctuations | Within 0.1 mmH$_2$O for ± 10% power supply voltage fluctuations |

**Note:** The following models are also available upon request. Details are available on request.

- * The model with 1/4 NPT input and output pressure connectors.
- * The model of psi gauge output pressure range.

YOKOGAWA ◆

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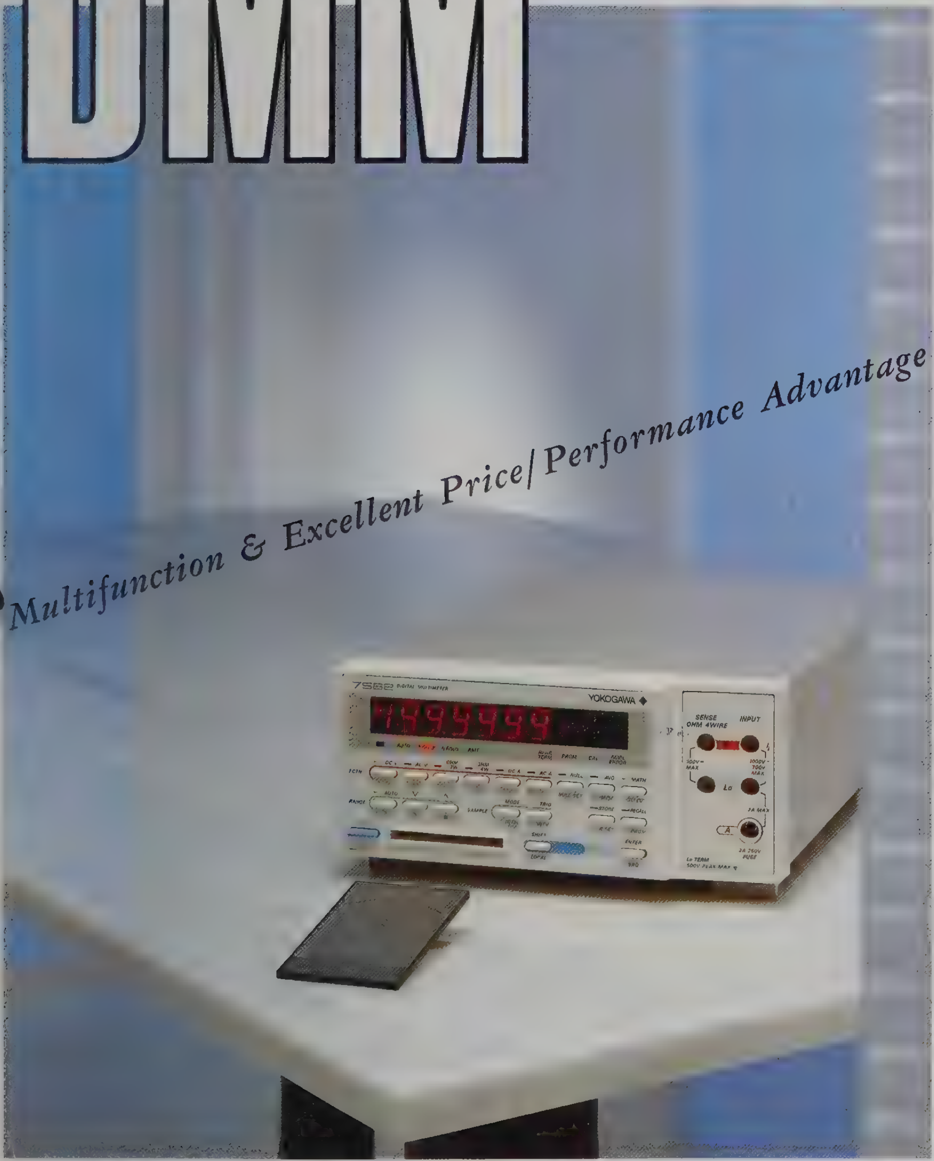
YOKOGAWA

# DMM

## Digital Multimeters



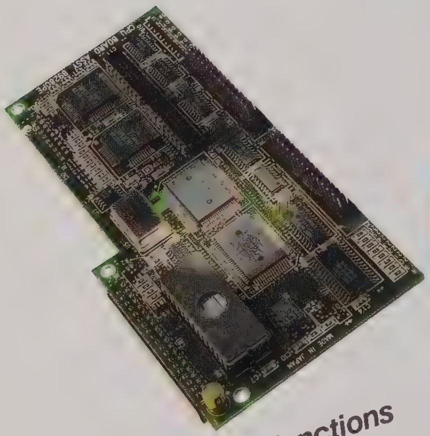
*Multifunction & Excellent Price/Performance Advantage*

## 7560 series 7561/7562 7550 series 7551/7552

Bulletin 7551-E

# *High Accuracy of 0.003%, High-Speed Sampling of 333 times/s.*

The 7550 & 7560 Series is a high-accuracy, high-speed sampling bench top digital multimeter lineup using a YOKOGAWA-original A-D converter (feedback pulse width modulation method), which features excellent stability, high noise immunity and linearity. In addition to the basic features, an optional IC memory card capable of storing 8,000 data and versatile measurement functions allow these multimeters to be used in diverse fields of applications, from bench to system uses.



*Computer-friendly functions through the use of YOKOGAWA-original ASIC*

## High accuracy, and excellent stability and linearity

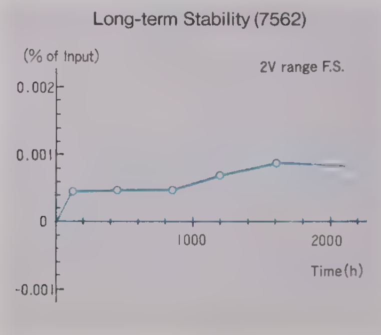
**■Models 7561 & 7562 (6-1/2 digits)**

| | |
|---|---|
| DC Voltage Accuracy | : ±0.003% of rdg ± 15 digits (90 days, 23 ± 5°C) |
| OHM Accuracy | : ±0.009% of rdg ± 30 digits (90 days, 23 ± 5°C) |

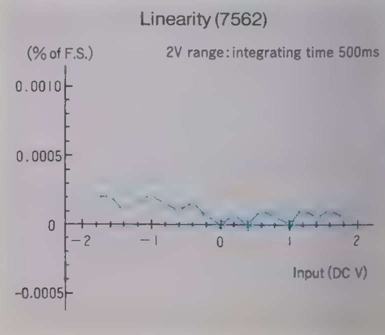
**■Models 7551 & 7552 (5-1/2 digits)**

| | |
|---|---|
| DC Voltage Accuracy | : ±0.005% of rdg ± 3 digits (90 days, 23 ± 5°C) |
| OHM Accuracy | : ±0.011% of rdg ± 5 digits (90 days, 23 ± 5°C) |

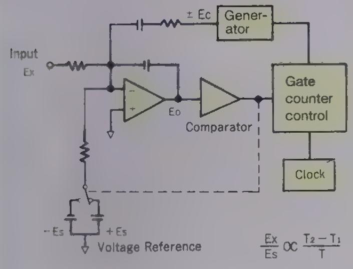
YOKOGAWA's proven feedback pulse width modulation (PWM) A-D converter features high noise immunity, high accuracy, excellent stability and linearity, and, provides reliable measurements. These converters can detect small change in signals.



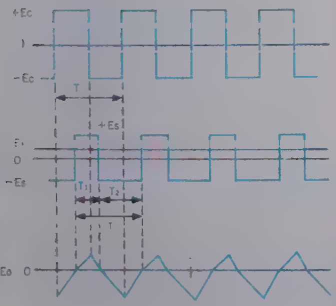
Long-term Stability (7562)



Linearity (7562)



Feedback Pulse Width Modulation Counting Technique



## High Throughput with High-Speed Sampling

7560 Series: 333 times/s
7550 Series: 125 times/s

The feedback PWM A-D converter, which includes a new counting system, allows a high-speed response without changing any excellent features. The sampling rate of 40 times/s can be obtained even with a 5-1/2 digit display. The 7550/7560 Series offer high system throughput with a large memory capacity, high-speed auto-ranging, programmable sampling interval, and integrating time.

## Powerful Functions Suitable for System Use

### ■A large memory capacity of 8,000 data by using memory card

The 7550 and 7560 Series can store the measured data of 1,000 data by using internal memory (or 8,000 data by using an optional memory card).

This allows high-speed sampling without being affected by transmission capacity via a communications bus.

Data can then be transferred to a controller after completing measurements.

These storage functions allow DMM's to be used as high-speed data logger.

### ■An input-site change between front and rear panels (7560 series)

The 7560 Series comes with voltage and resistance measurement terminals on both the front and rear panels.

This allows the use of the multimeters whether mounted on a bench or on a rack.

### ■GPIB or RS-232-C interface (standard)

The following functions are available with communication interface.

- Functions executed by panel key operation.
- Measured data output
- Panel-set data output
- Stored data output
- Status byte output

### ■A large current measurement of 20 A (Model 7552)

A 20 A current measurement terminal on the 7552 allows a large current measurement. This multimeter, combined with a programmable power supply, is ideal for a current monitor in an automatic test system.

# Versatile, Powerful Functions within a Compact Package.

## A Wide Variety of Applications from Bench to System Uses.

### Memory Card Expands Application Capability

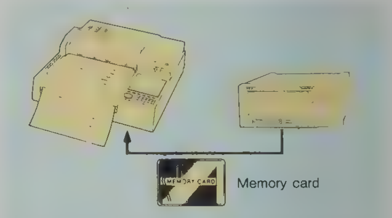
The 7550/7560 Series are the first DMM with memory card (optional).

Memory card allows you to:

- Save up to 8,000 measured data.
- Functions, ranges, and mathematical functions ON/OFF, and sample speed and so on, are saved.
- Setting programs using the front panel keys and measured data can be stored.
- Automatic loading at power ON.

7550/7560 Series get the more applications by the above memory card functions.

The data format of memory card is compatible with that of YOKOGAWA LR Series and HR Series Recorders, so the measured data can be recorded in analog form on strip chart.



**Connection Diagram for LR Series Recorder**

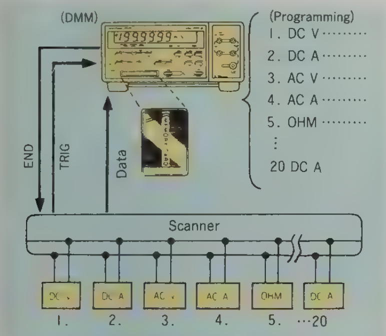
**Automatic loading**

Memory cards allow measurement parameters and conditions to be set without using the panel keys. If a memory card containing set data is inserted and then the power is turned ON, the memory contents are automatically read and programmings are set.

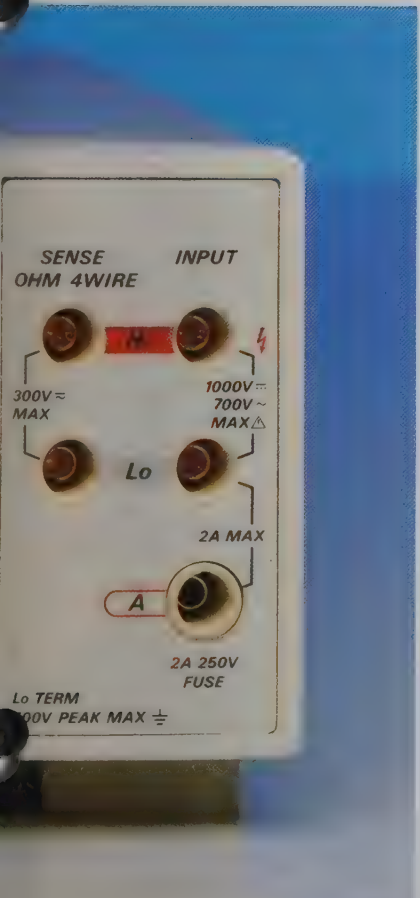
This is very useful for measurements that are repeated under the same conditions, and this can be a powerful support tool such as in the production line.

**Programming function**

If a memory card is installed, up to 20 steps can be programmed either by front panel key operations or via communication interfaces. The required functions, ranges, and mathematical functions can be set ON or OFF, and multichannel measurements can be performed in a combination with scanners.



Example of Programming



(actual size)

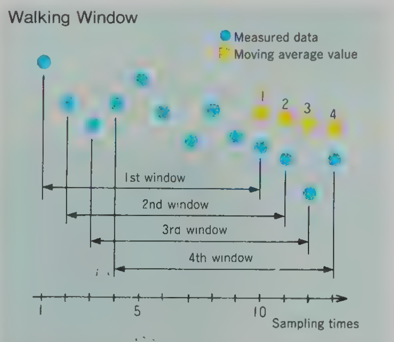
## Versatile Mathematical Functions

**Null Function (NULL)**

Null function cancell the input offset to zero. This NULL function is used to eliminate lead-wire resistance or cancel initial values.

**Averaging Function (AVG)**

The AVG function is used to average the measured data. This comes into effect when noise components or variation of measured data at high-speed sampling must be eliminated from the measured value.



Averaging Function (Number of averaging=10)

**Scaling**

The scaling function serves not only to indicate a multiple with preset multiplying factors but also to determine deviation from a preset reference value.

$Y = (X - A)/B$, where;

Y: Computed value,

X: Measured value,

A and B: Constants, where:

$-1999999E9 \leqq A \leqq 1999999E9$

$-1999999E9 \leqq B \leqq 1999999E9,\ B \neq 0$

**Decibel**

The decibel function serves to perform logarithmic operations (common logarithms) for measured values (or null or averaging values).

$Y = C \times \log_{10}(X/D)$, where;

Y: Computed value,

X: Measured value,

C and D: Constants, where:

$-1999999E9 \leqq C \leqq 1999999E9$

$-1999999E9 \leqq D \leqq 1999999E9,\ D \neq 0$

**Comparator**

The comparator function compares a measured value (or null or averaging values) with the reference value to determine which value is larger or smaller if we the measured value is within the limits.

$X \geqq H$...High

$H > X > L$...Pass

$L \geqq X$...Low

X: Measured value,

H and L: constants, where:

$-1999999E9 \leqq H \leqq 1999999E9$

$-1999999E9 \leqq L \leqq 1999999E9$

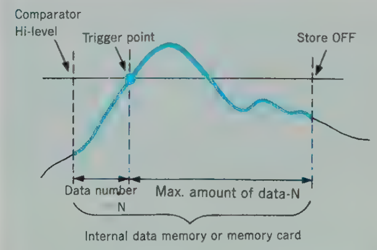
## CAL (Calibration) Function

The multimeters can be calibrated either by front panel key operations or via communication interfaces. The multimeters are calibrated without opening the case and any special calibration skills.

## Data Storage Functions

Measured data can be stored in memory. This allows high-speed measurements without being limited by the transmission speed via a communications bus. Three types of storage functions depending on the sampling mode are available. With a large buffer memory capacity, DMM's can be used as high-speed data loggers. In a sampling mode, the following functions can be used.

- **Pre-trigger (AUTO Mode)...** Data before generating a trigger signal can be measured. This is very useful combined with comparator function for analyzing data before an error occurs.



Pre-Trigger Function

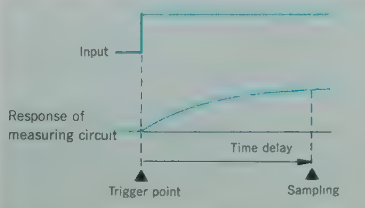
- **Preset counter (SINGLE Mode)...** A Data is stored in buffer memory each time a trigger signal is generated. When the measurement number reached to the preset number N, the measured data storage is automatically stopped.
- **Post-trigger (N RDGS Mode)...**

After generation of a trigger signal, data storage to buffer memory are repeated until the buffer memory is full. Measuring number (N) for each trigger generation can be preset.

## Time Delay (TD)

The time interval between a trigger signal generation and the sampling can be set from 0 to 60 minutes.

This allows accurate measurements when a signal source has dead-time or the measurement circuit shows a first-order lag response.



Time Delay

# *Powerful Lineup of Four Models*

## Cost effectiveness

- Model 7551 (5-1/2 digits)—its cost is almost identical to 4-1/2 digits DMMs.
- Model 7562 (6-1/2 digits, with accuracy and functions comparable to 7-1/2 digits DMM's)—its cost is half that of the 7-1/2 digits DMM's.

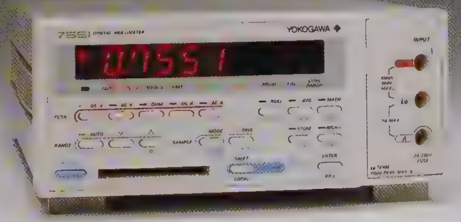
Measuring functions and accuracy, sampling rate, and display digits can be selected from among YOKOGAWA lineup of four DMM's.

Multimeters come with internal memory, abundant computational functions, and memory card slots, A GPIB or RS-232C interface is also provided as a standard feature, These digital multimeters are ideal for use in laboratories, R & D, or measurement systems.

## 7551

*5-1/2 digits, basic type*

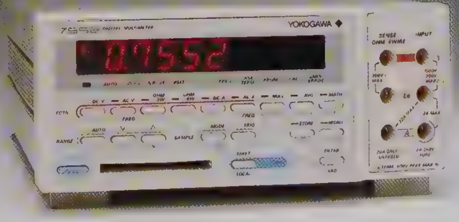
DC V | DC A | OHM-2W
AC Vmean | AC Amean
SAMPLE 125 | MATH
MEMO 1000 | IC Card
GP-IB | RS-232C



## 7552

*5-1/2 digits, multifunction type*

DC V | DC A | OHM-2W
OHM-4W
AC Vrms | AC Arms | freq
20A | SAMPLE 125 | MATH
MEMO 1000 | IC Card
GP-IB | RS-232C



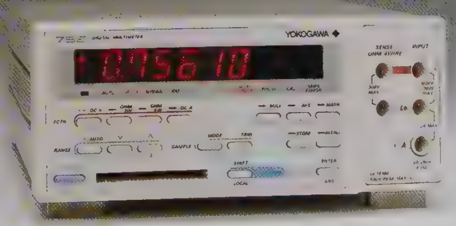
## SELECTION SYMBOLS

| Symbol | Meaning |
|---|---|
| DC V | DC Voltage |
| DC A | DC Current |
| OHM-2W | OHM 2-wire |
| OHM-4W | OHM 4-wire |
| AC Vmean | AC Voltage mean |
| AC Amean | AC Current mean |
| AC Vrms | AC Voltage rms |
| AC Arms | AC Current rms |
| freq | Frequency |
| 20A | 20 A Current |
| SAMPLE 333 | Sampling rate (333 times/s) |
| MATH | Mathematical function |
| MEMO 1000 | Internal memory (1,000 date) |
| IC Card | Memory card (8,000 data) |
| F/R | Input-site change between front and rear panels |
| GP-IB | GPIB Interface |
| RS-232C | RS-232C Interface |

## 7561

*6-1/2 digits, basic type*

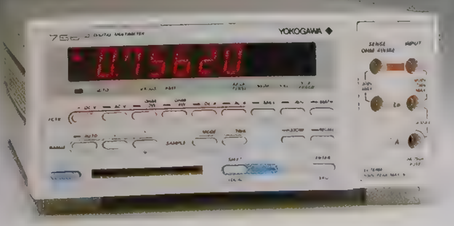
DC V | DC A | OHM-2W
OHM-4W
SAMPLE 333 | MATH
MEMO 1000 | IC Card | F/R
GP-IB | RS-232C



## 7562

*6-1/2 digits, with true RMS AC ranges.*

DC V | DC A | OHM-2W
OHM-4W
AC Vrms | AC Arms
SAMPLE 333 | MATH
MEMO 1000 | IC Card | F/R
GP-IB | RS-232C



# **7550**series (Common to 7551 & 7552)

## 1. DC Voltage (DC V)

● **Ranges:**

*16.7 ms shows 16.66.

| Range | Integrating time (100/20/16.7 ms)* | | Integrating time (2.5 ms) | | Input Resistance | Max. Input |
|---|---|---|---|---|---|---|
| | Max. Reading | Resolution | Max. Reading | Resolution | | |
| 200 mV | 199.999 | 1 μV | 199.99 | 10 μV | >1GΩ | ±1000V pk (10 sec)<br>±600V pk continuously between Hi and Lo |
| 2,000 mV | 1999.99 | 10 μV | 1999.9 | 100 μV | | |
| 20 V | 19.9999 | 100 μV | 19.999 | 1 mV | | |
| 200 V | 199.999 | 1 mV | 199.99 | 10 mV | 10 MΩ ±1% | ±1000V pk continuously |
| 1,000 V | 1100.00 | 10 mV | 1100.0 | 100 mV | | |

● **Accuracy (integrating time 100ms):** ±(% of reading + digits)

| Range | 24 hours, 23 ± 1°C | 90 days, 23 ± 5°C | 1 year, 23 ± 5°C | Temperature Coefficient(5 to 18, 28 to 40°C) |
|---|---|---|---|---|
| 200 mV | 0.005+6(4) | 0.008+8(4) | 0.011+8(4) | 0.001+1(.2) |
| 2,000 mV | 0.0035+3(3) | 0.005+3(3) | 0.008+3(3) | 0.0007+.5(.1) |
| 20 V | 0.007+4(4) | 0.012+4(4) | 0.02+4(4) | 0.0012+.5(.1) |
| 200 V | 0.006+3(3) | 0.011+3(3) | 0.019+3(3) | 0.0012+.5(.1) |
| 1,000 V | 0.008+3(3) | 0.013+3(3) | 0.021+3(3) | 0.0015+.5(.1) |

- Accuracy at 24 hours, 23±1°C is the value for the calibration standard.
- Auto Zero ON, Null
- Integrating time:
  At 20/16.7 ms, 2 is added to the value (digits) in integrating time 100 ms.
- ( ) indicates the value (digits) in integrating time 2.5 ms.
- At Auto Zero OFF, temperature coefficient of ±(0.003% of range+40 μV)/°C is added (at 5 to 40°C).

- **Common Mode Rejection:** 120 dB or more.
  Integrating time 100/20/16.7 ms, Rs=1kΩ, 50/60 Hz ±0.1%
- **Normal Mode Rejection:** 60 dB or more.
  Integrating time 100/20/16.7 ms, 50/60 Hz±0.1%
- **Maximum Allowable Voltage:** ±500 V peak between Lo and case.

## 2. DC Current (DC A)

● **Ranges:**

| Range | Integrating time (100/20/16.7 ms) | | Integrating time (2.5 ms) | | Input Resistance |
|---|---|---|---|---|---|
| | Max. Reading | Resolution | Max. Reading | Resolution | |
| 2 mA | 1.99999 | 10 nA | 1.9999 | 100 nA | <110 Ω |
| 20 mA | 19.9999 | 100 nA | 19.999 | 1 μA | <11 Ω |
| 200 mA | 199.999 | 1 μA | 199.99 | 10 μA | <1.2 Ω |
| 2,000 mA | 1999.99 | 10 μA | 1999.9 | 100 μA | <0.3 Ω |
| 20A (7552 only) | 19.9999 | 100 μA | 19.999 | 1 mA | <0.01 Ω |

● **Accuracy (integrating time 100 ms):**
±(% of reading+digits)

| Range | 1 year, 23 ± 5°C |
|---|---|
| 2 mA | 0.07+100 |
| 20 mA | 0.07+20 |
| 200 mA | 0.07+20 |
| 2,000 mA | 0.15+40 |
| 20A (7552 only) | 0.4+200 |

- Auto Zero ON.
- Integrating Time:
  At 20/16.7 ms, 20 is added to the value (digits) in integrating time 100 ms.
- **Temperature Coefficient:** ±(1/10 of measurement accuracy)/°C.

- **Allowable Current:**
  7551; 2A (2A fuse installed).
  7552; 2 to 2,000 mA range…2A (2A fuse installed), 20 A range…20 A (without fuse).

# **7560**series (Common to 7561 & 7562)

## 1. DC Voltage (DC V)

● **Ranges:**

| Range | Integrating time (500/200 ms) | | Integrating time (100/20/16.7 ms)* | | Integrating time (2.5/1.2 ms) | | Input Resistance | Max. Input |
|---|---|---|---|---|---|---|---|---|
| | Max. Reading | Resolution | Max. Reading | Resolution | Max. Reading | Resolution | | |
| 200 mV | 199.9999 | 0.1 μV | 199.999 | 1 μV | 199.99 | 10 μV | >1 GΩ | ±1000V pk (10 sec)<br>±600V pk continuously between Hi and Lo |
| 2,000 mV | 1999.999 | 1 μV | 1999.99 | 10 μV | 1999.9 | 100 μV | | |
| 20 V | 19.99999 | 10 μV | 19.9999 | 100 μV | 19.999 | 1 mV | | |
| 200 V | 199.9999 | 100 μV | 199.999 | 1 mV | 199.99 | 10 mV | 10 MΩ ± 1% | ±1000V pk continuously |
| 1,000 V | 1100.000 | 1 mV | 1100.00 | 10 mV | 1100.0 | 100 mV | | |

● **Accuracy (integrating time 500ms):** ±(% of reading + digits)

*16.7 ms shows 16.66.

| Range | 24 hours, 23 ± 1°C | 90 days, 23 ± 5°C | 1 year, 23 ± 5°C | Temperature Coefficient(5 to 18, 28 to 40°C) |
|---|---|---|---|---|
| 200 mV | 0.004+30(6) {4} | 0.005+40(8) {4} | 0.007+40(8) {4} | 0.0006+5(.6) {.2} |
| 2,000 mV | 0.0025+10(3) {3} | 0.003+15(3) {3} | 0.005+15(3) {3} | 0.0004+1(.2) {.1} |
| 20 V | 0.003+10(3) {3} | 0.004+15(3) {3} | 0.006+15(3) {3} | 0.0005+1(.2) {.1} |
| 200 V | 0.0045+10(3) {3} | 0.008+15(3) {3} | 0.015+15(3) {3} | 0.0007+1(.2) {.1} |
| 1,000 V | 0.005+10(3) {3} | 0.009+20(3) {3} | 0.016+20(3) {3} | 0.0008+1(.2) {.1} |

- Accuracy at 24 hours, 23±1°C is the value for the calibration standard.
- Auto Zero ON, Null
- Integrating time: At 200 ms, 2 is added to the value (digits) in integrating time 500 ms.
- ( ) indicates the value (digits) in integrating time 100 ms. For integrating time 20/16.7 ms, 2 is added to the value (digits) enclosed in the parentheses.
- { } indicates the value (digits) in integrating time 2.5 ms. For integrating time 1.2 ms, 2 is added to the value (digits) enclosed in the brackets.

- At Auto Zero OFF, temperature coefficient of ±(0.0015% of range+25 μV)/°C is added (at 5 to 40°C)
- **Common Mode Rejection:** 120 dB or more.
  Integrating time 500/200/100/20/16.7 ms, RS=1 kΩ, 50/60 Hz ±0.1%
- **Normal Mode Rejection:** 60 dB or more.
  Integrating time 500/200/100/20/16.7 ms, 50/60 Hz ±0.1%
- **Maximum Allowable Voltage:** ±500 V peak between Lo and case.

## 2. DC Current (DC A)

● **Ranges:**

| Range | Integrating time (500/200/100/20/16.7 ms) | | Integrating time (2.5/1.2 ms) | | Input Resistance |
|---|---|---|---|---|---|
| | Max. Reading | Resolution | Max. Reading | Resolution | |
| 2 mA | 1.99999 | 10 nA | 1.9999 | 100 nA | <110 Ω |
| 20 mA | 19.9999 | 100 nA | 19.999 | 1 μA | <11 Ω |
| 200 mA | 199.999 | 1 μA | 199.99 | 10 μA | <1.2 Ω |
| 2,000 mA | 1999.99 | 10 μA | 1999.9 | 100 μA | <0.3 Ω |

● **Accuracy (integrating time 500 ms):**
±(% of reading + digits)

| Range | 1 year, 23 ± 5°C |
|---|---|
| 2 mA | 0.05+100 |
| 20 mA | 0.05+20 |
| 200 mA | 0.05+20 |
| 2,000 mA | 0.1+40 |

- Auto Zero ON.
- Integrating Time:
  At 200/100/20/16.7 ms, 20 is added to the value (digits) in integrating time 500 ms.

- **Temperature Coefficient:** ±(1/10 of measurement accuracy)/°C.
- **Allowable Current:** 2A (2A fuse installed).

## 3. Resistance (OHM)

**● Ranges:**

| Range | Integrating time (100/20/16.7 ms) | | Integrating time (2.5 ms) | | Current through unknown |
|---|---|---|---|---|---|
| | Max. Reading | Resolution | Max. Reading | Resolution | |
| 200 Ω | 199.999 | 1 mΩ | 199.99 | 10 mΩ | 1 mA |
| 2,000 Ω | 1999.99 | 10 mΩ | 1999.9 | 100 mΩ | 1 mA |
| 20 kΩ | 19.9999 | 100 mΩ | 19.999 | 1 Ω | 100 μA |
| 200 kΩ | 199.999 | 1 Ω | 199.99 | 10 Ω | 10 μA |
| 2,000 kΩ | 1999.99 | 10 Ω | 1999.9 | 100 Ω | 1 μA |
| 20 MΩ | 19.9999 | 100 Ω | 19.999 | 1 kΩ | 100 nA |
| 200 MΩ | 199.999 | 1 kΩ | 199.99 | 10 kΩ | 50 nA |

**● Accuracy (4-wire system, integrating time 100 ms):** ±(% of reading + digits)

| Range | 24 hours, 23±1°C | 90 days, 23±5°C | 1 year, 23±5°C | Temperature Coefficient (5 to 18, 28 to 40°C) |
|---|---|---|---|---|
| 200 Ω | 0.008+6(4) | 0.014+7(4) | 0.018+7(4) | 0.002+1(1) |
| 2,000 Ω | 0.007+4(3) | 0.011+6(3) | 0.015+6(3) | 0.0015+1(.2) |
| 20 kΩ | 0.007+3(3) | 0.011+5(3) | 0.015+5(3) | 0.0015+1(.2) |
| 200 kΩ | 0.008+3(3) | 0.012+5(3) | 0.016+5(3) | 0.0015+1(.2) |
| 2,000 kΩ | 0.03+15(20) | 0.05+20(30) | 0.05+20(30) | 0.005+1(.2) |
| 20 MΩ | 0.25+30 | 0.25+30 | 0.25+30 | 0.02+3 |
| 200 MΩ | 2+200 | 2+200 | 2+200 | 0.05+5 |

- Accuracy at 24 hours, 23±1°C is the value for the calibration standard.
- 2-wire system is available only for 7551 (4mΩ/°C is added to each wire).
- Auto Zero ON, Null.
- Integrating Time: At 20/16.7 ms, 2 is added to the value (digits) in integrating time 100 ms.
- ( ) indicates the value (digits) in integrating time 2.5 ms.
- For 20 and 200 MΩ at sampling interval 400 ms or more. Accuracy is not prescribed in integrating time 2.5 ms.
- At Auto Zero OFF, temperature coefficient on 200Ω range is ±(0.015% of range)/°C, on other ranges ±(0.005% of range)/°C is added at 5 to 40°C.
- Excluding the influence of leadwires.
- **Open Circuit Voltage:** 10 V max. (12.5 V max. on 200 MΩ range).
- **Maximum Input Voltage:** ±300 V peak or 300 V rms (between Hi and Lo).
- **Response Time:** 0.4 s or less on 2,000 kΩ/20 MΩ ranges, 5 s or less on 200 MΩ range.

## 4. AC Voltage (AC V)

**● Ranges:**

| Range | Integrating time (100/20/16.7 ms) | | Integrating time (2.5 ms) | | Input Resistance | Max. Input |
|---|---|---|---|---|---|---|
| | Max. Reading | Resolution | Max. Reading | Resolution | | |
| 200 mV | 199.999 | 1 μV | 199.99 | 10 μV | 1 MΩ ±2%, approx. 150 pF | 700 V rms or ±1,000V pk between Hi and Lo |
| 2,000 mV | 1999.99 | 10 μV | 1999.9 | 100 μV | | |
| 20 V | 19.9999 | 100μV | 19.999 | 1 mV | | |
| 200 V | 199.999 | 1 mV | 199.99 | 10 mV | | |
| 700 V | 700.00 | 10 mV | 700.0 | 100 mV | | |

**● Accuracy (integrating time 100ms):** ±(% of reading + digits), 1 year, 23±5°C

| Range | 20 Hz to 30 Hz | 30 Hz to 45 Hz | 45 Hz to 10 kHz | 10 kHz to 20 kHz | 20 kHz to 50 kHz | 50 kHz to 100 kHz |
|---|---|---|---|---|---|---|
| 200 mV | 0.9+200 | 0.5+200 | 0.4+200 | 0.5+300 | 0.8+500 | 2+500 |
| 2,000 mV | 0.8+100 | 0.4+100 | 0.2+100 | 0.4+200 | 0.6+500 | 2+500 |
| 20 V | 0.8+100 | 0.4+100 | 0.2+100 | 0.4+200 | 0.6+500 | 2+500 |
| 200 V | 1.0+100 | 0.4+100 | 0.3+100 | 0.4+200 | 0.8+500 | 3+500 |
| 700 V | 1.0+100 | 0.4+100 | 0.4+100 | 0.6+300 | | |

- Auto Zero ON.
- Integrating Time: At 20/16.7 ms, 20 is added to the value (digits) in integrating time 100 ms.
- **AC Coupling:** Mean value rectification (calibrated to rms value) (7551), true rms value (7552).
- Input Voltage: 5 to 100% of range (sine wave).
- **Response Time:** 400 ms or less (to reading within ±0.2% of final value).
- **Crest Factor:** Up to 3 (7552 only) (at full scale, up to 2 at full scale on 700 V range).
- **Temperature Coefficient:** ±(1/10 of measurement accuracy)/°C.

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## 3. Resistance (OHM)

**● Ranges:**

| Range | Integrating time (500/200 ms) | | Integrating time (100/20/16.7 ms) | | Integrating time (2.5/1.2 ms) | | Current through unknown |
|---|---|---|---|---|---|---|---|
| | Max. Reading | Resolution | Max. Reading | Resolution | Max. Reading | Resolution | |
| 200 Ω | 199.9999 | 100 μΩ | 199.999 | 1 mΩ | 199.99 | 10 mΩ | 1 mA |
| 2,000 Ω | 1999.999 | 1 mΩ | 1999.99 | 10 mΩ | 1999.9 | 100 mΩ | 1 mA |
| 20 kΩ | 19.99999 | 10 mΩ | 19.9999 | 100 mΩ | 19.999 | 1 Ω | 100 μA |
| 200 kΩ | 199.9999 | 100 mΩ | 199.999 | 1 Ω | 199.99 | 10 Ω | 10 μA |
| 2,000 kΩ | 1999.999 | 1 Ω | 1999.99 | 10 Ω | 1999.9 | 100 Ω | 1 μA |
| 20 MΩ | 19.9999 | 100 Ω | 19.9999 | 100 Ω | 19.999 | 1 kΩ | 100 nA |
| 200 MΩ | 199.999 | 1 kΩ | 199.999 | 1 kΩ | 199.99 | 10 kΩ | 50 nA |

**● Accuracy (4-wire system, integrating time 500 ms):** ±(% of reading + digits)

| Range | 24 hours, 23±1°C | 90 days, 23±5°C | 1 year, 23±5°C | Temperature Coefficient (5 to 18, 28 to 40°C) |
|---|---|---|---|---|
| 200 Ω | 0.007+40 (6) {4} | 0.011+50 (7) {4} | 0.014+50 (7) {4} | 0.0012+10 (2) {.5} |
| 2,000 Ω | 0.005+25 (4) {3} | 0.009+35 (6) {3} | 0.012+35 (6) {3} | 0.001+2(.5) {.1} |
| 20 kΩ | 0.005+20 (3) {3} | 0.009+30 (5) {3} | 0.012+30 (5) {3} | 0.001+2 (.5) {.1} |
| 200 kΩ | 0.007+20 (3) {3} | 0.01+30 (5) {3} | 0.013+30 (5) {3} | 0.001+2 (.5) {.1} |
| 2,000 kΩ | 0.02+135(15) {20} | 0.03+150 (20) {30} | 0.05+150(20){30} | 0.004+2 (.5) {.1} |
| 20 MΩ | 0.2+30 (30) | 0.2+30 (30) | 0.2 +30 (30) | 0.02+1 (1) |
| 200 MΩ | 2+200 (200) | 2+200 (200) | 2+200 (200) | 0.05+2(2) |

- Accuracy at 24 hours, 23±1°C is the value for the calibration standard.
- Auto Zero ON, Null.
- Integrating Time: At 200 ms, 2 is added to the value (digits) in integrating time 500 ms.
- ( ) indicates the value (digits) in integrating time 100 ms. For integrating time 20/16.7 ms, 2 is added to the value (digits) enclosed in the parentheses.
- { } indicates the value (digits) in integrating time 2.5 ms. For integrating time 1.2 ms, 2 is added to the value (digits) enclosed in the brackets.
- For 20 and 200 MΩ at sampling interval 400 ms or more. Accuracy is not prescribed in integrating time 1.2/2.5 ms.
- At Auto Zero OFF, temperature coefficient on 200 Ω range is ±(0.013% of range)/°C, on other ranges ±(0.003 % of range)/°C is added (at 5 to 40°C)
- For 2-wire system, 2 mΩ/°C is added.
- Excluding the influence of leadwires.
- **Open Circuit Voltage:** Max. 10 V. (12.5 V max, on 200 MΩ range)
- **Maximum Input Voltage:** ±300 V peak or 300 V rms (between Hi and Lo).
- **Response Time:** 0.4 s or less on 2,000 kΩ/20 MΩ ranges 5 s or less on 200 MΩ range.

## 4. AC Voltage (AC V) (7562 only)

**● Ranges:**

| Range | Integrating time (500/200/100/20/16.7 ms) | | Integrating time (2.5/1.2 ms) | | Input Resistance | Max. Input |
|---|---|---|---|---|---|---|
| | Max. Reading | Resolution | Max. Reading | Resolution | | |
| 200 mV | 199.999 | 1 μV | 199.99 | 10 μV | 1 MΩ ±2% Approx. 150 pF | 700 V rms or ±1,000 V pk between Hi and Lo |
| 2,000 mV | 1999.99 | 10 μV | 1999.9 | 100 μV | | |
| 20 V | 19.9999 | 100 μV | 19.999 | 1 mV | | |
| 200 V | 199.999 | 1 mV | 199.99 | 10 mV | | |
| 700 V | 700.00 | 10 mV | 700.0 | 100 mV | | |

**● Accuracy (integrating time 500 ms):** ±(% of reading + digits), 1 year, 23 ±5°C

| Range | 20 Hz to 30 Hz | 30 Hz to 45 Hz | 45 Hz to 10 kHz | 10 kHz to 20 kHz | 20 kHz to 50 kHz | 50 kHz to 100 kHz |
|---|---|---|---|---|---|---|
| 200 mV | 0.9+200 | 0.5+200 | 0.3+200 | 0.3+300 | 0.7+500 | 2+500 |
| 2,000 mV | 0.8+100 | 0.4+100 | 0.15+100 | 0.3+200 | 0.5+500 | 2+500 |
| 20 V | 0.8+100 | 0.4+100 | 0.15+100 | 0.3+200 | 0.5+500 | 2+500 |
| 200 V | 1+100 | 0.4+100 | 0.3+100 | 0.3+200 | 0.7+500 | 3+500 |
| 700 V | 1+100 | 0.4+100 | 0.3+100 | 0.3+300 | — | — |

- Auto Zero ON.
- Integrating Time: At 200, 100, 20/16.7 ms, 20 is added to the value (digits) in integrating time 500 ms.
- **AC Coupling:** True rms value.
- Input Voltage: 5 to 100% of range (sine wave).
- **Response Time:** 400 ms or less (to reading within ±0.2 % of final value).
- **Crest Factor:** Up to 3 (at full scale, up to 2 at full scale on 700 V range).
- **Temperature Coefficient:** ±(1/10 of measurement accuracy)/°C.

# 7550series (Common to 7551 & 7552)

## 5. AC Current (AC A)

- **Ranges:**

| Range | Integrating time (100/20/16.7 ms) | | Integrating time (2.5 ms) | | Input Resistance (50 Hz) |
|---|---|---|---|---|---|
| | Max. Reading | Resolution | Max. Reading | Resolution | |
| 2 mA | 1.99999 | 10 nA | 1.9999 | 100nA | <110 Ω |
| 20 mA | 19.9999 | 100 nA | 19.999 | 1 μA | <11 Ω |
| 200 mA | 199.999 | 1 μA | 199.99 | 10 μA | <1.2 Ω |
| 2,000 mA | 1999.99 | 10 μA | 1999.9 | 100 μA | <0.3 Ω |
| 20A (7552 only) | 19.9999 | 100 μA | 19.999 | 1 mA | <0.01 Ω |

- **Accuracy (integrating time 100 ms):** ±(% of reading + digits), 1 year, 23 ±5°C

| Range | 20 Hz to 30 Hz | 30 Hz to 45 Hz | 45 Hz to 2 kHz | 2 kHz to 5 kHz |
|---|---|---|---|---|
| 2 mA | 1.5 + 350 | 0.8 + 250 | 0.5 + 300 | 0.8 + 300 |
| 20 mA | 1.3 + 300 | 0.8 + 200 | 0.5 + 200 | 0.8 + 200 |
| 200 mA | 1.3 + 300 | 0.8 + 200 | 0.5 + 200 | 0.8 + 200 |
| 2,000 mA | 1.5 + 300 | 1.5 + 200 | 1.0 + 200 | 1.5 + 200 |
| 20 A (7552 only) | 2 + 300 | 2 + 300 | 1.2 + 300 | —— |

- Auto Zero ON.
- Integrating Time: At 20/16.7 ms, 20 is added to the value (digits) in integrating time 100 ms.
- **AC coupling:** Mean value rectification (calibrated to rms value) (7551), true rms value (7552).
- Input Current: 5 to 100% of range (sine wave).
- **Response Time:** 400 ms or less (to reading within ±0.2% of final value).
- **Crest Factor:** Up to 3 (7552 only).
- **Temperature Coefficient:** ±(1/10 of measurement accuracy)/°C.
- **Allowable Current:**
  7551: 2A (2A fuse installed).
  7552: 2 to 2,000 mA range…2A (2A fuse installed),
  20A range…20A (without fuse).

## 6. Frequency (FREQ) *(7552 only)*

- **Ranges:**

| Range | Frequency Range and Display |
|---|---|
| 200 Hz | 20.000 to 199.999 Hz |
| 2,000 Hz | 180.00 to 1999.99 Hz |
| 20 kHz | 1.8000 to 19.9999 kHz |
| 200 kHz | 18.000 to 199.999 kHz |

- **Measuring Principle:** Reciprocal system.
- **Fundamental Frequency Accuracy:** ±100 ppm (5 to 40°C).
- **Input:** Depends on AC V or AC A range (selected just before the measurement).
- **Input Sensitivity:** 5% of V/A ranges.

## 7. Interface

- **GPIB Interface**

**Electrical & Mechanical Specifications:** Conforms to IEEE St'd 488-1978.

**Interface Function & Identification:** SH1, AH1, T5, L4, SR1, RL1, PP0, DC1, DT1, C0.

Address Mode, address and header ON/OFF can be settable.

- **RS-232C Interface**

**Transmission System:** Start-stop system.

**Data Transfer Rates:** 75, 150, 300, 600, 1200, 2400, 4800, 9600 bps.

Hand Shake Mode, bps rate, No. of bits and header ON/OFF can be settable.

**Sampling Interval; Refer to Specifications of 7560 Series (bottom of this page).**

# 7560series (Common to 7561 & 7562)

## 5. AC Current (AC A) *(7562 only)*

- **Ranges:**

| Range | Integrating time (500/200/100/20/16.7 ms) | | Integrating time (2.5/1.2 ms) | | Input Resistance (50 Hz) |
|---|---|---|---|---|---|
| | Max. Reading | Resolution | Max. Reading | Resolution | |
| 2 mA | 1.99999 | 10 nA | 1.9999 | 100 nA | <110 Ω |
| 20 mA | 19.9999 | 100 nA | 19.999 | 1 μA | <11 Ω |
| 200 mA | 199.999 | 1 μA | 199.99 | 10 μA | <1.2 Ω |
| 2,000 mA | 1999.99 | 10 μA | 1999.9 | 100 μA | <0.3 Ω |

- **Accuracy (integrating time 500 ms):** ±(% of reading + digits), 1 year, 23±5°C

| Range | 20 Hz to 30 Hz | 30 Hz to 45 Hz | 45 Hz to 2 kHz | 2 kHz to 5 kHz |
|---|---|---|---|---|
| 2 mA | 1.4 + 350 | 0.8 + 250 | 0.5 + 250 | 0.8 + 300 |
| 20 mA | 1.2 + 300 | 0.8 + 200 | 0.5 + 200 | 0.8 + 200 |
| 200 mA | 1.2 + 300 | 0.8 + 200 | 0.5 + 200 | 0.8 + 200 |
| 2,000 mA | 1.5 + 300 | 1.5 + 200 | 1.0 + 200 | 1.5 + 200 |

- Auto Zero ON
- Integrating Time: At 200, 100, 20/16.7 ms, 20 is added to the value (digits) in integrating time 500 ms.
- **AC Coupling:** True rms value
- Input Current: 5 to 100% of range (sine wave).
- **Response Time:** 400 ms or less (to reading within ±0.2% of final value).
- **Crest Factor:** Up to 3
- **Temperature Coefficient:** ±(1/10 of measurement accuracy) /°C.
- **Allowable Current:** 2A (2A fuse installed).

## 6. Interface

- **GPIB Interface**

**Electrical & Mechanical Specifications:** Conforms to IEEE St'd 488-1978.

**Interface Function & Identification:** SH1, AH1, T5, L4, SR1, RL1, PP0, DC1, DT1, C0

Address Mode, address and header ON/OFF can be settable.

- **RS-232-C Interface**

**Transmission System:** Start-stop system.

**Data Transfer Rates:** 75, 150, 300, 600, 1200, 2400, 4800, 9600 bps.

Hand Shake Mode, bps rate, No. of bits and header ON/OFF can be settable.

## 7. Sampling Interval *(Common to 7550/7560 Series)*

| Integrating time | Measurement intervals (in AUTO Zero OFF) | Measurement intervals (in AUTO Zero ON) |
|---|---|---|
| 1.2ms | 3ms(333/S) | 7ms(143/S) |
| 2.5ms | 8ms(125/S) | 15ms(66.7/S) |
| 16.7ms | 25ms(40/S) | 45ms(22.2/S) |
| 20ms | 30ms(33.3/S) | 55ms(18.2/S) |
| 100ms | 110ms(9.1/S) | 215ms(4.7/S) |
| 200ms | 210ms(4.8/S) | 415ms(2.4/S) |
| 500ms | 510ms(2/S) | 1015ms(1/S) |

- • 7560 Series only
  sampling mode is AUTO, NULL; off, AVG: off, MATH: off, function: DC V in a fixed range, without communication function, using buffer memory.
- Data of sampling interval shows min. value (fastest sample rate). Measurement intervals can be settable more than the value of left table.

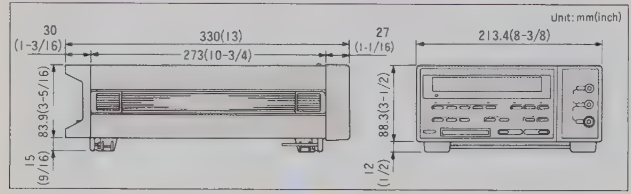
## General Specifications (7551/7552, 7561/7562)

**Operating Principle:** Feedback pulse width modulation method.
**Sample Mode:** Auto/Single/N reading.
**Sampling Interval:** 8 ms to 60 min (7551/7552), 3 ms to 60 min (7561/7562), (1 ms min., 1s at 3s or more)
**Maximum Reading:** 199999 (7551/7552), 1999999 (7561/7562).
**Overrange Information:** –oL– sign display.
**Data Memory:** 1,000 data, measured data can be stored and recalled: (STORE/RECALL).
**Ranging:** AUTO, MANUAL, (remote control and programming possible).
**Operating Temperature Range:** 5 to 40°C (41 to 104°F).
**Humidity Range:** 20 to 80% relative humidity.
**Warmup Time:** Approx. 60 minutes to rated accuracy.
**Power Requirements:** 100 or 115, 200 or 230 V AC (must be specified), 50 or 60 Hz.
**Power Consumption:** 20 VA max.
**Dimensions (Approx.):** 88(H) × 213(W) × 300(D) mm, (3-1/2 × 8-5/8 × 11-7/8").
**Weight (Approx.):** 3 kg (6.6 lbs).
**Accessories supplied at no extra cost:** Power cord (2- or 3-prong type) ... 1 set, measuring leads...1 set, fuse (0.2A time lag)...1 pc, fuse (2A FAST)...1 pc., remote connector...1 pc.

## Model and Suffix Codes

| Model | Suffix Codes | | Description | |
|---|---|---|---|---|
| **755101** | ········· | ········· | 5.5 digits | DC V, DC A, OHM, AC V, AC A(GPIB) |
| **755102** | ········· | ········· | | DC V, DC A, OHM, AC V, AC A,(RS-232C) |
| **755201** | ········· | ········· | | DC V, DC A, f, OHM, AC V, AC A(GPIB) |
| **755202** | ········· | ········· | | DC V, DC A, f, OHM, AC V, AC A(RS-232C) |
| **756101** | ········· | ········· | 6.5 digits | DC V, DC A, OHM(GPIB) |
| **756102** | ········· | ········· | | DC V, DC A, OHM(RS-232C) |
| **756201** | ········· | ········· | | DC V, DC A, OHM, AC V, AC A(GPIB) |
| **756202** | ········· | ········· | | DC V, DC A, OHM, AC V, AC A(RS-232C) |
| Version up | **-B** | ········· | Always B | |
| Power require-ments | **-1** | ········· | 100 V AC(50 or 60 Hz) | |
| | **-3** | ········· | 115 V AC(50 or 60 Hz) | |
| | **-5** | ········· | 200 V AC(50 or 60 Hz) | |
| | **-7** | ········· | 230 V AC(50 or 60 Hz) | |
| Power Cord | **/B** | ········· | JIS standard | |
| | **/D** | ········· | UL standard | |
| | **/F** | ········· | VDE standard | |
| | **/G** | ········· | SAA standard | |
| Optional feature | **/DA** | | D-A converter output | |

## Dimensions (7551/7552, 7561/7562)



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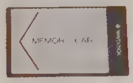
## Optional Accessories

4-wire resistance measuring lead (751510)

Shielded test leads (B9409LA)



Memory card
(378901, 378902, 378903)

Input terminal adaptor (751512)

20A measuring lead (751513)

## Optional Accessories

| Name | Code | Description |
|---|---|---|
| Memory card (8K bytes) | **378901** | Setting & measured data |
| Memory card (16K bytes) | **378902** | Setting & measured data |
| Memory card (64K bytes) | **378903** | Setting & measured data |
| Dummy card | **B9586NG** | Dust cap for memory card slot |
| Shielded test leads | **B9409LA** | Alligator type, 0.8m |
| Rack mounting kit | **751501** | EIA (single mounting) |
| Rack mounting kit | **751502** | EIA (double mounting) |
| Rack mounting kit | **751503** | JIS (single mounting) |
| Rack mounting kit | **751504** | JIS (double mounting) |
| 4-wire resistance measuring lead | **751510** | 0.6 m |
| Input terminal adaptor | **751512** | |
| 20A measuring lead | **751513** | 0.8 m |

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# 2501A, 2502A & 2506A Digital Multimeters

## 2501A PRECISION DIGITAL MULTIMETER

GP·IB

110 x 440 x 410mm 10.5kg...2501A23
(4-3/8 x 17-3/8 x 16-1/8" 23.1 lbs)

### MAIN FEATURES

- **Top-grade accuracy (50 ppm, DC V), and sensitivity (0.1μV DC)**
- **5-1/2-digit (high speed)/6-1/2-digit (high resolution) display selectable at the push of a button**
- **True RMS reading (2501A21 & 23)**
- **5 user-programmable calculating functions**
  Scaling, % deviation, comparator, null and data averaging.
- **Fully-programmable using a GPIB (standard on all models)**
- **Analog output (2501A22 & 23)**
- **Suitable for both bench and system applications**

**Programmable calculating functions (2501A & 2502A)**

| Calculating function | Calculating formula | 2501A | 2502A |
|---|---|---|---|
| Scaling | $Y = \frac{X - A}{B}$ | ○ | ○ |
| % deviation (1) | $Y (\%) = \frac{X - A}{A} \times 100$ | ○ | |
| % deviation (2) | $Y (\%) = \frac{X - A \times \frac{n}{B}}{A} \times 100$ | | ○ |
| Comparator | $A - B (\%) < X < A + B (\%)$ | ○ | ○ |
| Null | $Y = X - X_o$ | ○ | ○ |
| Data averaging | $Y = \frac{\overset{B}{\Sigma} Xi}{B}$ | ○ | |

Where,

| | | | |
|---|---|---|---|
| Y......... | Data to be displayed. | $X_o$ .... | Initially measured value. |
| X ... .... | Measured value. | n ..... | Number of steps (automatic setting). |
| A & B.. | Programmable values (.000000 to ±999999). | | |

**Available Models**

| Model | Functions |
|---|---|
| **2501A20** | DC voltage and resistance |
| **2501A21** | DC voltage, resistance and AC voltage |
| **2501A22** | DC voltage and resistance (with analog output) |
| **2501A23** | DC voltage, resistance and AC voltage (with analog output) |

### GENERAL SPECIFICATIONS

**Operating Principle:** High-speed feedback pulse width modulation counting method (integrating type).

**Display:** 7-segment red LED display.

**Maximum Reading:** 1199999 (6-1/2-digit) or 119999 (5-1/2-digit).

**Ranging:** Automatic or manual (remote control possible).

**Unit Marks:** mV, V, Ω, kΩ, MΩ, %.

**Overrange Information:** —OL— display.

**Sample Rate:** Approx. 3 times/s (5-1/2-digit), 2 times/s (6-1/2-digit) or HOLD (remote control possible).

**Operating Temperature Range:** 5 to 40°C (41 to 104°F).

**Humidity Range:** Up to 80% relative humidity.

**Warm-up Time:** Approx. 60 minutes.

**Dielectric Strength:** 1,500V AC for one minute between power line and case.

**Insulation Resistance:** More than 100MΩ at 500V DC between power line and case.

**Power Requirements:** 100, 120, 200, 220 or 240V AC (must be specified), 50 and 60Hz.

**Power Consumption:** Approx. 50VA...2501A 23.

**Accessories supplied at no extra cost:** **B9409LA**(289821) test leads... 1 set, **B9409LE**(289822) 4-wire test leads ... 1 set, **A9024KC**(309977) remote control connector plug ... 1 pc., fuses ... 2 pcs., rack adaptor ... 2 pcs., power cord (2- or 3-prong type) ... 1 set.

# 2501A

## ■ DC MILLIVOLT

**Ranges:** ±10mV, ±100mV, ±1V, ±10V.
**Overrange:** Approx. 20% on all ranges.
**Sensitivity:** 0.1µV on 10mV range (5-1/2-digit).
**Accuracy:** 24 hours, 23±1°C,
*10mV range .........±[0.005% of rdg. + 2(**20) digits],
*100mV range ........±[0.003% of rdg. + 1(5) digit(s)],
1 & 10V ranges ......±[0.002% of rdg. + 1(3) digit(s)].
90 days, 23±5°C,
*10mV range ........±[0.01% of rdg. + 2(**20) digits],
*100mV range .......±[0.005% of rdg. + 1(5) digit(s)],
1 & 10V ranges .......±[0.005% of rdg. + 1(5) digit(s)].
( ) ..... 6-1/2-digit display, *... after zero adjustment,
** .... 10 digits for 10-time averaging.
**Zero Stability:** 0.3µV/h, 0.5µV/7h (after one hour warm-up, 23±5°C).
**Temperature Coefficient:** (5 to 18°C and 28 to 40°C)
10mV range ...........±(0.0008% of rdg. + 0.03µV)/°C,
100mV range ..........±(0.0005% of rdg. + 0.03µV)/°C,
1 & 10V ranges .......±(0.0004% of rdg. + 0.00002% of range)/°C.
**Input Resistance:** More than 1,000MΩ.
**Response Time (Approx.):** 600ms (5-1/2-digit) or 1,000ms (6-1/2-digit).
**Common Mode Rejection:** More than 160dB at 50 or 60Hz±0.1%.
**Normal Mode Rejection:** More than 100dB at 50 or 60Hz±0.1%.
**Maximum Input:** 50V peak (common mode voltage 500V peak).

## ■ DC VOLTAGE

**Ranges:** ±100mV, ±1V, ±10V, ±100V, ±1,000V.
**Overrange:** Approx. 20% on all except 1,000V range.
**Sensitivity:** 1µV on 100mV range (5-1/2-digit).
**Accuracy:** 24 hours, 23±1°C,
*100mV range .......±[0.003% of rdg. + 1(**10) digit(s)],
1 to 1,000V ranges ..±[0.002% of rdg. + 1 (3) digit(s)].
90 days, 23±5°C,
*100mV range ........±[0.005% of rdg. + 1(**10) digit(s)],
1 to 1,000V ranges ..±[0.005% of rdg. + 1 (5) digit(s)].
( ) ..... 6-1/2-digit display, *... after zero adjustment,
** ... 5 digits for 10-time averaging.
**Temperature Coefficient:** (5 to 18°C and 28 to 40°C)
100mV range .........±(0.0005% of rdg. + 0.03µV)/°C,
1 to 1,000V ranges ..±(0.0004% of rdg. +0.002% of range)/°C.
**Input Resistance:** 100mV to 10V ranges... more than $10^4$ MΩ, 100 & 1,000V ranges... 10MΩ±1%.
**Response Time (Approx.);** 140ms (5-1/2-digit) or 600ms (6-1/2-digit).
**Common Mode Rejection:** More than 120dB at 50 or 60Hz ±0.1%.
**Normal Mode Rejection:** More than 60dB at 50 or 60Hz ±0.1%.
**Maximum Input:** 1,000V peak (common mode voltage 500V peak).

## ■ RESISTANCE

**Ranges:** 100Ω, 1kΩ, 10kΩ, 100kΩ, 1,000kΩ, 10MΩ, 100MΩ.
**Overrange:** Approx. 20% on all ranges.
**Sensitivity:** 1mΩ on 100Ω range (5-1/2-digit).
**Accuracy:** 24 hours, 23±1°C,
100Ω range ................ ±[0.003% of rdg. + 2(20) digits],
1 to 100kΩ ranges ...... ±[0.002% of rdg. + 1(3) digit(s)],
1MΩ range ................. ±[0.003% of rdg. + 1(3) digit(s)],
10MΩ range ............... ±[0.01% of rdg. + 1(6) digit(s)],
100MΩ range ........... ±[0.1% of rdg. + 1(6) digit(s)].
90 days, 23±5°C,
100Ω range ...............±[0.006% of rdg. + 3(30) digits],
1 to 100kΩ ranges .......±[0.005% of rdg. + 1(5) digit(s)],
1MΩ range ................±[0.007% of rdg. + 1(5) digit(s)],
10MΩ range ...............±[0.01% of rdg. + 3(30) digits],
100MΩ range ........... ±[0.1% of rdg. + 3(30) digits].
( )... 6-1/2-digit display.
**Temperature Coefficient:** (5 to 18°C and 28 to 40°C)
100Ω & 1kΩ ranges..±(0.0006% of rdg. +0.001% of range)/°C.
10 & 100kΩ ranges.. ±(0.0005% of rdg. + 0.00005% of range)/°C,
1 & 10MΩ ranges.. ±(0.001% of rdg. +0.00005% of range)/°C.
100MΩ range...... ±(0.01% of rdg.+0.00005% of range)/°C.
**Current through Unknown:**

| Range | 100Ω | 1kΩ | 10kΩ | 100kΩ | 1MΩ | 10MΩ | 100MΩ |
|---|---|---|---|---|---|---|---|
| Current | 1mA | | | 100µA | 10µA | 1µA | 0.1µA |

**Response Time (Approx.):**

| Display / Range | 5-1/2-digit | 6-1/2-digit |
|---|---|---|
| 100Ω | 1s | 1s |
| 1kΩ to 1MΩ | 140ms | 600ms |
| 10MΩ | 800ms | 1.2s |
| 100MΩ | 2.1s | 2.5s |

**Maximum Input:** 500V peak.

## ■ AC VOLTAGE (TRUE RMS) ..... 2501A21 & 2501A23

**Ranges:** 1V, 10V, 100V, 500V.
**Overrange:** Approx. 20% on all ranges.
**Sensitivity:** 1µV on 1V range (5-1/2-digit).
**Accuracy:**

| Frequency / Calibration cycle | 50 to 500Hz | 40Hz to 20kHz | 20 to 100kHz |
|---|---|---|---|
| 24 hours, 23±1°C | ±(0.05% of rdg. +0.02% of range) | ±(0.1% of rdg. +0.05% of range) | ±(0.5% of rdg. +0.2% of range) |
| 90 days, 23±5°C | ±(0.07% of rdg. +0.03% of range) | ±(0.15% of rdg. +0.07% of range) | ±(0.7% of rdg. +0.3% of range) |

**Temperature Coefficient:** (5 to 18°C and 28 to 40°C)
±(0.007% of rdg. + 0.003% of range)/°C.
**Crest Factor:** Up to 5.
**Input Impedance:** 1MΩ ± 1% in parallel with less than 100pF.
**Response Time:** Approx. 600ms (5-1/2-digit) or 1s(6-1/2-digit).
**Common Mode Rejection:** More than 80dB at 50 or 60Hz.
**Maximum Input:** 100V peak (DC component of less than 500V, common mode voltage 500V peak).

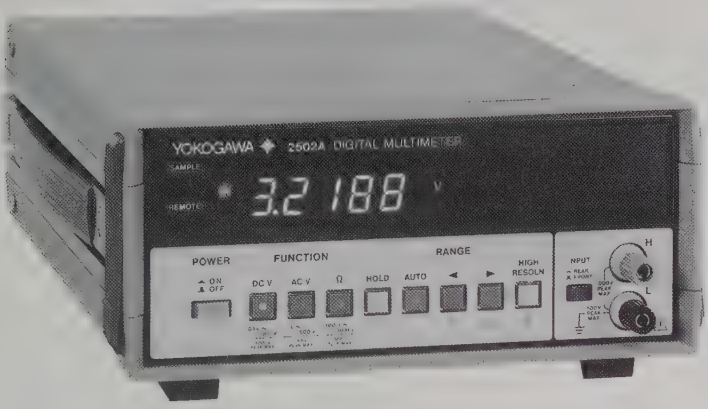
## ■ ANALOG OUTPUT ... 2501A22 & 2501A23

**D-A Conversion Output:** D-A conversion of the 2 or 3 least significant digits (LSD) may be selected from the remote control input connector.
**Accuracy:** ±1 digit.
**Maximum Output Current:** 1mA.

## ■ General Purpose Interface Bus (GPIB)

Functional, electrical and mechanical specifications ... meets IEEE Standard 488-1975.
Interface function and identification ... SH1, AH1, T5, L4, SR1, RL1, PP0, DC1, DT1, C0.

# 2502A DIGITAL MULTIMETER



GP·IB

99 x 233 x 364mm 5.7kg...2502A23
(3-7/8 x 9-1/4 x 14-3/8" 12.6 lbs)

Model 2502A is a compact, 5-1/2-digit digital multimeter using a high-speed pulse width modulation technique (integrating type) of excellent noise immunity. It provides three measurement functions of DC V, AC V and Ω, and four calculating functions. All operations and programming are very simple merely by depressing the pushbuttons.

## MAIN FEATURES

- **High accuracy (0.01%, DC V), and sensitivity (1μV DC)**
- **4-1/2-digit (high speed)/5-1/2-digit (high resolution) display selectable at the push of a button**
- **True RMS reading (2502A21 & 23)**
- **High-speed autoranging**
- **User-programmable 4 calculating functions useful for data analysis on production lines and testing**
  Scaling, % deviation, comparator and null.
- **Fully-programmable using a GPIB (2502A22 & 23)**

### Available Models

| Model | Functions |
|---|---|
| **2502A20** | DC voltage and resistance |
| **2502A21** | DC voltage, resistance and AC voltage |
| **2502A22** | DC voltage and resistance (with GPIB) |
| **2502A23** | DC voltage, resistance and AC voltage (with GPIB) |

## GENERAL SPECIFICATIONS

**Operating Principle:** High-speed feedback pulse width modulation counting method (integrating type).

**Display:** 7-segment red LED display.

**Maximum Reading:** 119999 (5-1/2-digit) or 11999 (4-1/2-digit), pushbutton selectable.

**Ranging:** Automatic or manual (remote control possible with GPIB model).

**Unit Marks:** mV, V, Ω, kΩ, MΩ, %.

**Overrange Information:** —OL— display.

**Sample Rate:** Approx. 5 times/s(4-1/2-digit), 2 times/s (5-1/2-digit) or HOLD (remote control possible).

**Operating Temperature Range:** 5 to 40°C (41 to 104°F).

**Humidity Range:** Up to 80% relative humidity.

**Warm-up Time:** Approx. 30 minutes.

**Dielectric Strength:** 1,500V AC for one minute between power line and case.

**Insulation Resistance:** More than 100MΩ at 500V DC between power line and case.

**Power Requirements:** 100, 120, 200, 220 or 240V AC (must be specified), 50 and 60Hz.

**Power Consumption:** Approx. 40VA (2502A23)

**Accessories supplied at no extra cost: B9409LA**(289821) test leads... 1 set, fuses (0.5A)... 2 pcs., **A9024KC**(309977) remote control connector plug... 1 pc., power cord (2- or 3-prong type)... 1 set.

### ■ DC VOLTAGE

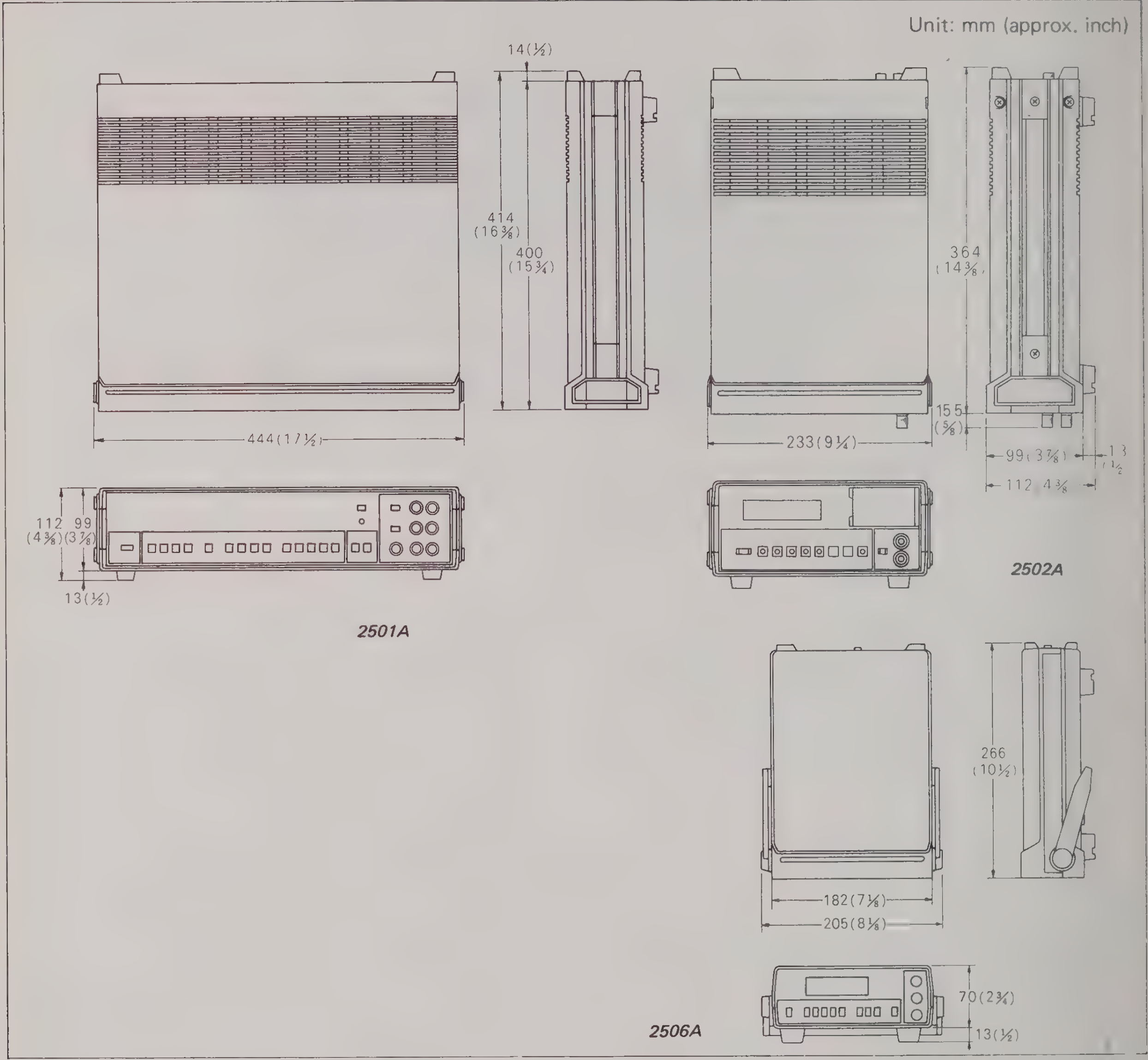
**Ranges:** ±100mV, ±1V, ±10V, ±100V, ±1,000V.

**Overrange:** Approx. 20% on all except 1,000V range.

**Sensitivity:** 1μV on 100mV range (5-1/2-digit).

**Accuracy:** 90 days, 23±5°C, ( )... 5-1/2-digit display,
100mV range .............. ±[0.02% of rdg. + 1(4) digit(s)],
1 & 10V ranges .......... ±[0.01% of rdg. + 1(2) digit(s)],
100 & 1,000V ranges ... ±[0.02% of rdg. + 1(2) digit(s)].

## DIMENSIONS



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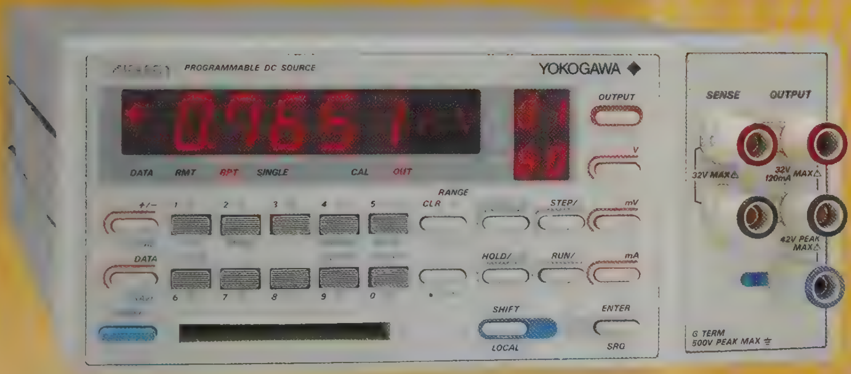
# 7651

## Programmable DC Source

High accuracy···0.01%(voltage)/0.02%(current),
High resolution···100nV/10nA,
High-speed response···10ms/±0.1%,
Low noise of 15μ Vp-p
Sink and source function (4-quadrant operation)
Bipolar output enables smooth polarity switching



# PROGRAMMABLE DC SOURCE

# Fast Response and High Accuracy.

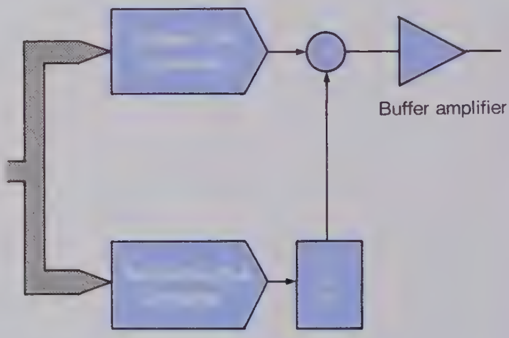
Model 7651 is a general-purpose DC source developed on the basis of long-term DC standard technology.
The dual multiplying D-A converter has enabled the compatibility of high-speed response and high resolution. The 7651 also provides high accuracy and stability. In addition to the source function (current supply), the sink function (current absorption) is also available, so the 7651 can be used as not only DC voltage/current source but also high-precision electronic load. Further, a series of powerful functions to meet the system use such as the programming function up to 50 steps, the memory card capable of storing 7 patterns of programs, and GPIB or RS-232-C interface are provided as standard.
This 7651 can be used for a wide range of fields from the R & D to production line, service and maintenance.

---

## ■High precision output

High accuracy : ±0.01% of setting ±200μV
(10 V range, 90 days, 23±5°C)
±0.02% of setting ±100nA
(1 mA range, 90 days, 23±5°C)
High resolution : 100nV (DCV, 10 mV range)
High-speed response : 10ms/±0.1%
Low noise : 15μVp-p (1 V range, DC to 10 Hz)

**○ Dual multiplying D-A converter**

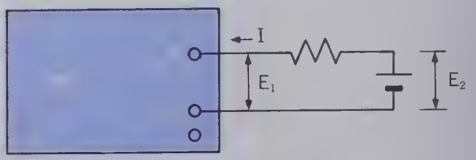


The 7651 uses multiplying D-A converter technology. Extremely high resolution is realized through the use of dual digital to analog converters. In addition, the linearity is further enhanced by software driven compensation technique. Superior output with high accuracy is assured in all the ranges.

## ■Sink and source

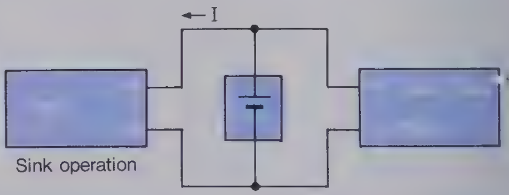
Conventional DC sources usually have the function of power supply (source) only without power absorption (sink) function. In addition to the source function, the sink is available, so the 7651 can be used for the discharge characteristics of batteries or the output characteristics of power supply as a constant current electronic load.
Further, the 4-quadrant operation becomes available by sink and source function, so both capacitive and inductive loads can be driven by the 7651.

**○ As a reliable constant voltage source**



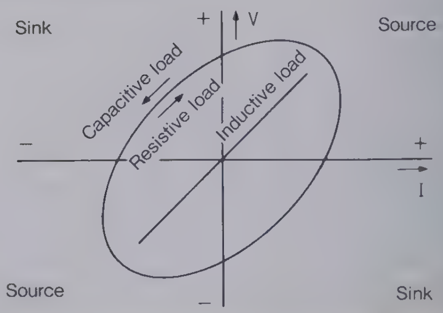
E1→E2 Sink operation, The generation of constant voltage is possible even with active load.

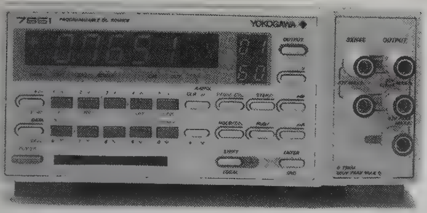
**○ Discharge characteristics test of battery**



Constant current discharge characteristics

**○ 4-quadrant operation**

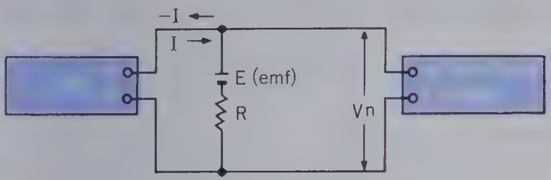




## Bipolar output, glitchless

The bipolar output of the 7651 executes polarity switching without using mechanical contact, so any abnormal voltage or current does not generate at the polarity switching. Because of this feature, true continuous output change from the negative maximum output to the positive maximum output becomes possible. An evaluation of zero cross comparator or polarity switching for the cancellation of emf at the experiment of solid-state physics can easily be made.
Any glitch does not generate at the change of range settings.

○ **Resistance measurement of superconductivity**



$V_1 = I \cdot R + E$

$V_2 = -I \cdot R + E$

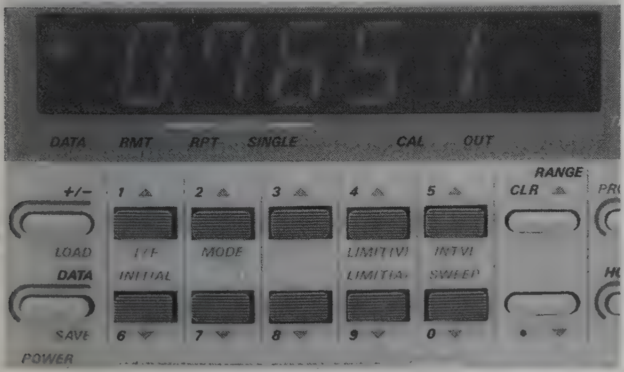
$\therefore V_1 - V_2 = 2I \cdot R$

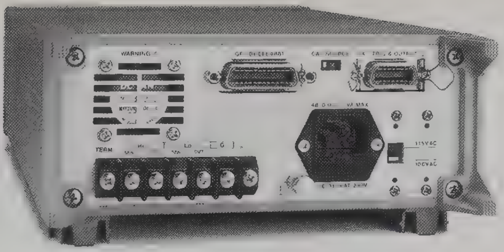
## Easy-to-operate design

**●Two types of data setting mode**

You can select the following two types of data setting mode in accordance with your application.

- Continuous variable mode···The setting is made on each digit by depressing the corresponding up/down key. When you continue depressing the up/down key, the output value changes continuously.
- Data mode........... The setting data are directly entered by ten-keys.





**●Programmable voltage/current limiter**

Limiting point is programmable within the range of 1 to 30 V as the voltage limiter, and within the range of 5 to 120 mA as the current limiter.
Even if the limiter is actuated by overload or short-circuit of output and so on, the 7651 automatically recover from limit to normal state by removing of the overload.

**●Calibration function**

Calibration software is integrated in the 7651, and calibration is executed by the key operation on the front panel or through communication without opening the case. So, anyone can maintain the accuracy of the 7651 without difficulty by its calibration function.

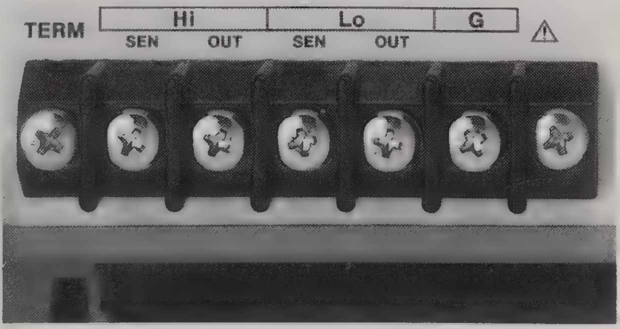
**●GPIB or RS-232-C interface (Standard)**

The GPIB or RS-232-C interface can be selected according to your system needs. The following functions are available through these interfaces.

- Functions executed by panel key operation
- Setting data output
- Panel set data output
- Program step setting/reading
- Status byte output

**●Output from the front or rear is selectable**

In addition to the front output terminal model, the 7651 includes the rear output terminal model. This allows the use of the 7651 where mounted on a bench or on a rack.



Rear Output Terminals (765111/765112)

## General specifications

**Operating principle:** Multiplication type dual D-A conversion

**Output setting:** +120000 (setting range), continuous variable mode, data mode

**Display:** 7-segment LED

**Unit indication:** 5×7 dot-matrix LED, mV/V/mA

**Overload indication:** "-oL-" sign display

**Allowable input voltage:** 32V/120mA between Hi-Lo, 42V peak between Lo-G, 500V peak between G-Case

**Operating temperature range:** 5 to 40°C (41 to 104°F)

**Humidity range:** 20 to 80% R.H.

**Warm-up time (approx.):** 60 minutes

**Power supply*:** 100/115V AC ±10%, 50/60Hz, selectable by switch.

* As to source voltage, 200/230V, prescription is needed. Change-over operable.

**Power Consumption (approx.):** 30VA

**Dimensions (approx.):** 88(H)×213(W)×350(D)mm, (3-1/2×8-7/16×13-13/16")

**Weight (approx.):** 3.6kg (7.92lbs)

**Standard Accessories:** Power cord…1 set., fuse (315mA, time rag)…2 pcs., remote connector…1 pc., instruction manual…1 copy

## Model, Suffix and Option codes

| Model | Suffix Codes | | | Description |
|---|---|---|---|---|
| 765101 | | | | Front output terminal model, GPIB |
| 765102 | | | | Front output terminal model, RS-232-C |
| 765111 | | | | Rear output terminal model, GPIB |
| 765112 | | | | Rear output terminal model, RS-232-C |
| | -A | | | Always **A** (version code) |
| Power Requirements | | -1 | | 100V AC (50 & 60Hz), (115V AC) |
| | | -3 | | 115V AC (50 & 60Hz), (100V AC) |
| | | -5 | | 200V AC (50 & 60Hz), (230V AC) |
| | | -7 | | 230V AC (50 & 60Hz), (200V AC) |
| Power Cord | | | /B | JIS standard |
| | | | /D | UL standard |
| | | | /F | VDE standard |
| | | | /G | SAA standard |

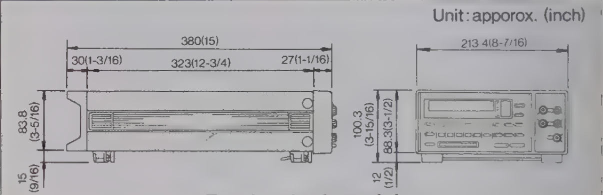
## Optional accessories for 7651

| Name | Code | Description |
|---|---|---|
| Memory card (8K bytes) | 378901 | Setting data, 1pc./unit |
| Dummy card | B9586NG | Dust cap for memory card slot, 2pcs./unit |
| Shielded test leads | B9409LA | Alligator type, 0.8m, 1pc./unit |
| Rack mounting kit | 751501 | EIA, single mounting, 1pc./unit |
| Rack mounting kit | 751502 | EIA, double mounting, 1pc./unit |
| Rack mounting kit | 751503 | JIS, single mounting, 1pc./unit |
| Rack mounting kit | 751504 | JIS, double mounting, 1pc./unit |

Front output model

Rear output model

## Dimensions (7651)



Front output model

YOKOGAWA

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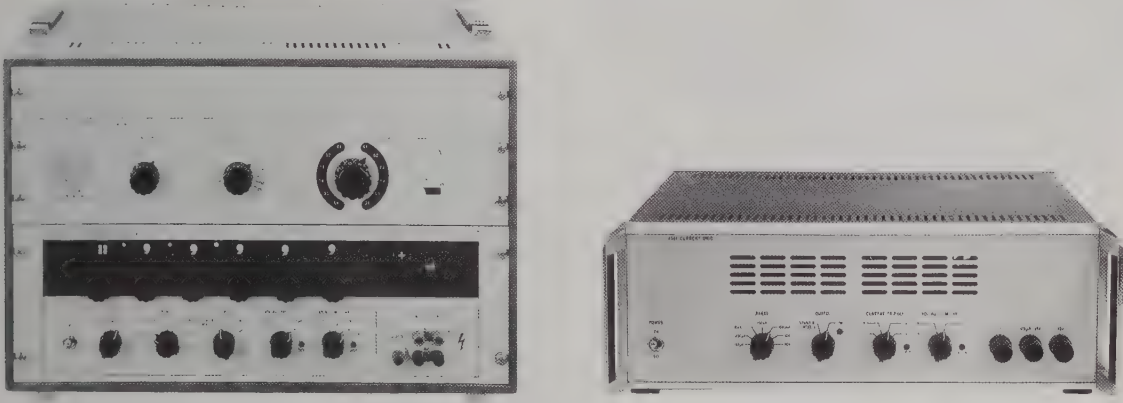
# 2550 & 2560
# DC Calibration Sets

## 2550

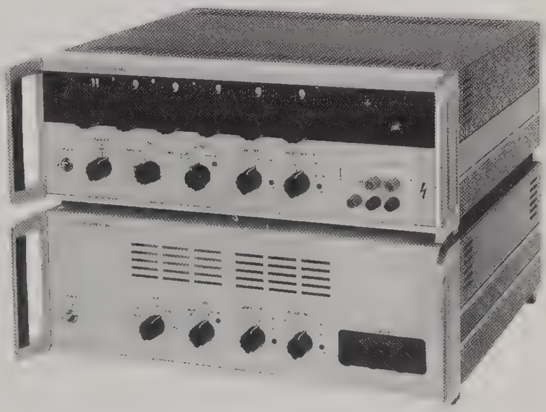


*255001 DC voltage/current calibration set*

Series 2550 DC Calibration Sets are stable, high-precision DC sources, which assure speedy, simple testing and calibration of DC instruments. Series 2550 are selectable from three different models: 255001 DC Voltage/Current Calibration Set(composed of 255201 DC Voltage Standard, Current Unit and Deviation Unit), 255002 DC Voltage Calibration Set(composed of 255201 DC Voltage Standard and Deviation Unit) and 255003 DC Voltage/Current Standard(composed of 255201 DC Voltage Standard and Current Unit).

By using Deviation Unit, the testing or calibrating deviation can be directly read out in percent of the rated value without needs for cumbersome, time-consuming calculation of deviation.

The specifications of Series 2550 and combination instruments are described on the following pages. For details on 2552, refer to Bulletin 2500F.



*255003 DC voltage/current standard*

### AVAILABLE MODELS

| Model<br>Function | 255001 | 255002 | 255003 |
|---|---|---|---|
| ■ Voltage supply (0 to ±1,200V DC in 4 range with ±0.005% accuracy) | ● | ● | ● |
| ■ Current supply (0 to 36A DC in 7 ranges with ±0.01% to ±0.2% accuracy) | ● | — | ● |
| ■ %-error (percent deviation) measurement | ● | ● | — |

## SPECIFICATIONS OF 2550

| **Model** | | **255001** | **255002** | **255003** |
|---|---|---|---|---|
| **Name** | | DC voltage/current calibration set | DC voltage calibration set | DC voltage/current standard |
| **Composition** | | 255201 DC voltage standard, current unit and deviation unit | 255201 DC voltage standard and deviation unit | 255201 DC voltage standard and current unit |
| **Output Voltage** | | 0 to 1,199.99V DC | 0 to 1,199.99V DC | 0 to 1,199.99V DC |
| **Voltage Ranges** | | 1,000mV/10V/100V/1,000V (four ranges) | 1,000mV/10V/100V/1,000V (four ranges) | 1,000mV/10V/100V/1,000V (four ranges) |
| **Output Current** | | 0 to 35.9999A DC | — | 0 to 35.9999A DC |
| **Current Ranges** | | 100µA/1 000µA/10mA/100mA/ 1,000mA/10A/30A (seven ranges) | — | 100µA/1,000µA/10mA/100mA/ 1,000mA/10A/30A (seven ranges) |
| **Deviation Dial** | | –0.6 to +0.6%, –3.0 to +3.0% (two ranges) | –0.6 to +0.6%, –3.0 to +3.0% (two ranges) | — |
| **Accuracy of Output** | **Voltage** | ±0.005% of setting | ±0.005% of setting | ±0.005% of setting |
| | **Current** | ±0.01% to ±0.2% of setting | — | ±0.01% to ±0.2% of setting |
| **Deviation Accuracy** | **Voltage** | ±0.085% on ±0.6% deviation range,<br>±0.205% on ±3.0% deviation range | ±0.085% on ±0.6% deviation range,<br>±0.205% on ±3.0% deviation range | — |
| | **Current** | ±0.09% to ±0.28% on ±0.6% deviation range,<br>±0.21% to ±0.40% on ±3.0% deviation range | — | — |
| **Dimensions(approx.)** | | 255201 and deviation unit:<br>316 x 497 x 400mm<br>(12-1/2 x 19-5/8 x 15-3/4")<br>Current unit:<br>149 x 439 x 415mm<br>(5-7/8 x 17-1/4 x 16-3/8") | 316 x 497 x 400mm<br>(12-1/2 x 19-5/8 x 15-3/4") | 255201:<br>149 x 439 x 415mm<br>(5-7/8 x 17-1/4 x 16-3/8")<br>Current unit:<br>149 x 439 x 415mm<br>(5-7/8 x 17-1/4 x 16-3/8") |
| **Weight (approx.)** | | 255201 and deviation unit:<br>33.5kg (74.8 lbs)<br>Current unit: 28kg (61.7 lbs) | 33.5kg (74.8 lbs) | 255201:<br>19kg (41.9 lbs)<br>Current unit: 28kg (61.7 lbs) |

Note: Overall accuracy of 255001 or 255002 (using deviation Unit):

Overall accuracy = (2552 accuracy) + (deviation unit accuracy) . . . voltage output.
= (current unit accuracy) + (deviation unit accuracy) . . . current output.

Deviation unit accuracy = (division accuracy) + (deviation dial accuracy)

Examples: When the deviation dial is set at –3.0 to +3.0%,
Overall accuracy = ±(0.005% + 0.05% + 0.15%)
= ±0.21% . . . voltage output.
= ±(0.01% + 0.05% + 0.15%)
= ±0.21% . . . current output.

## DEVIATION UNIT

In testing the full scale (rated) value of an DC indicating or measuring instrument or calibrating the instrument, the Deviation Unit directly indicates the testing or calibrating deviation in percentage to an accuracy of ±0.6% to ±3.0% of full scale value. Since it is so designed as to widely used for DC indicating or measuring instruments with a 100-, 120-, 150-, (20-, 50-, 12-, 24-, 30-, 75-, etc.) division scale, this unit covers almost all DC voltmeters and ammerters.

## CURRENT UNIT

**Current Rages:**

| Range | Output Current | Max. Output Voltage | Steps |
|---|---|---|---|
| 100µA | 0 to 119.9999µA | approx. 20V | 0.1nA |
| 1,000µA | 0 to 1,199.999µA | approx. 20V | 1nA |
| 10mA | 0 to 11.99999mA | approx. 20V | 10nA |
| 100mA | 0 to 119.9999mA | approx. 20V | 100nA |
| 1,000mA | 0 to 1,199.999mA | approx. 10V | 1µA |
| 10A | 0 to 11.99999A | approx. 1.5V | 10µA |
| 30A | 0 to 35.9999A | approx. 1V | 100µA |

**Accuracy of Output:** (in combination with 2552, for 3-month calibration period, at ambient temperature of 23±2°C, relative humidity of 45 to 75%, rated power supply voltage and rated load)

| Range | Accuracy of Output (whichever is greater) |
|---|---|
| 100µA | ±(0.02% of setting) or ±2nA |
| 1,000µA | ±(0.01% of setting) or ±10nA |
| 10mA | ±(0.01% of setting) or ±100nA |
| 100mA | ±(0.01% of setting) or ±1µA |
| 1,000mA | ±(0.03% of setting) or ±30µA |
| 10A | ±(0.1% of setting) or ±1mA |
| 30A | ±(0.2% of setting) or ±18mA |

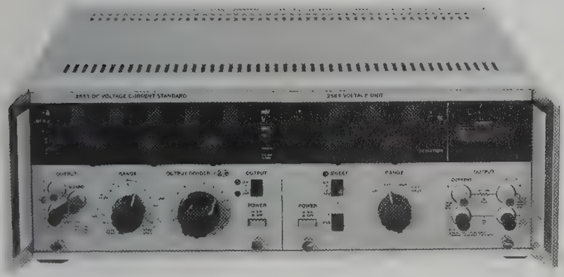
**Overcurrent Protection (Current Trip):** Automatically sets output current to zero at the following levels; approx. 1,2A/12A/20A/36A on all ranges

**Overvoltage Protection (Voltage Limit):** Automatically limits output voltage at the following levels; approx. 5V/10V/15V/20V on all ranges

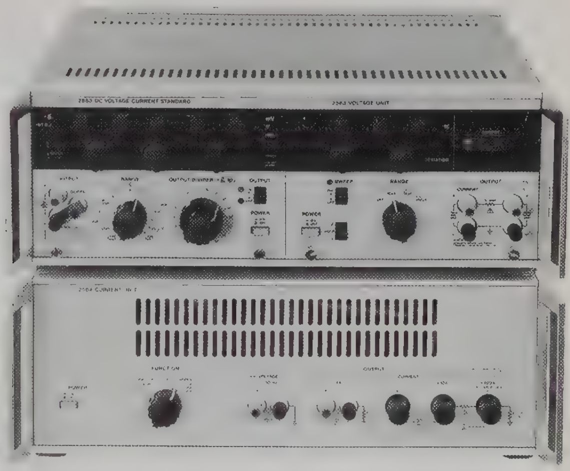
**Power Requirements:** 100, 115, 200, 215 or 230V AC±10% (must be specified), 47 to 63Hz

# 2560

GP-IB



256041



256042

Series 2560 DC Calibration Sets are stable, precision sources which assure simple, fast testing and calibration of DC instruments. Four different models are available: Type 2553 DC Voltage/Current Standard and voltage unit; 2553, voltage and current units; with or without a General Purpose Interface Bus (GPIB) that meets the IEEE 488 Standard.

Standard models in the Series feature many versatile functions including a fractional output divider, %-error measurement, and sweep mode. An optional GPIB allows Series 2560 to be interfaced with other instruments, or applied in an automatic calibrator or test system. For details on 2553, refer to Bulletin 2500R.

## AVAILABLE MODELS

| Model | Composition |
|---|---|
| **2560□1** | 2553 DC voltage/current standard and voltage unit |
| **2560□2** | 2553, voltage unit and current unit |
| **2560□3** | 2553 and voltage unit with GPIB |
| **2560□4** | 2553, voltage unit and current unit with GPIB |

*Specify temperature setting range in □ by one of code: $\boxed{4}$ for ANSI or JIS (°C), or $\boxed{2}$ for DIN (°C)

## GENERAL SPECIFICATIONS

**Output Setting:** 3 dials (opto-setting using photocouplers), 1st and 2nd dials . . . 16 steps, 3rd dial . . . 32 steps.

**Setting Value Indication:** 5-digit red LED display.

**Output Unit Marks:** mV, V, mA or °C.

**OUTPUT DIVIDER:** DIVIDER output = output setting $\times \frac{n}{m}$, m . . . 1, 2 through 15 in 15 uniform divisions, n . . . 0, 1 through 15 ($n \leqq m$).

**Accuracy of Output Divider:** Within ±1 digit of LSD.

**% DEVIATION Setting:** 2 dials on the front panel of voltage unit (opto-setting using photocouplers), up to 9.99% of output setting.

**% DEVIATION Indication:** 3-digit LED display of up to 9.99% indication.

**SWEEP Speed:** Approx. 16 seconds for sweep from 0 to 100% of setting or 100% to 0.

**Calibration Cycle:** 3 months.

**Operating Temperature Range:** 5 to 40°C (41 to 104°F).

**Humidity Range:** 20 to 80% relative humidity.

**Warmup Time:** Approx. 30 minutes.

**Power Requirements:** 100, 120, 200, 220 or 240V AC±10% (must be specified), 50 and 60Hz.

**Dimension (Approx.):** 256001, 256003 . . . 149 x 439 x 415mm (5-7/8 x 9 x 14-3/8''), 256002, 256004 . . . two cases of above.

**Weight (Approx.):** 2560□1, 2560□3 . . . 13.5 kg (29.8 lbs), 2560□2, 2560□4 . . . 34 kg (75 lbs).

**Accessories supplied at no extra cost:** Power cord (2- or 3-prong type) . . . 2 sets (2560□1, 2560□3), 3 sets (2560□2, 2560□4), Fuses (1A) . . . 2 pcs, Fuses (1A, time-lag type) . . . 2 pcs, Fuses (5A) . . . 2 pcs.

## VOLTAGE UNIT OF 2560

| Range | Output voltage/ current | *Accuracy of output (% of setting) | Resolution | Maximum output (approx.) | Internal resistance (approx.) | Noise (1Hz to 1kHz, typical data) |
|---|---|---|---|---|---|---|
| 100V | 0 to 120.00V | ±(0.15% + 20mV) | 0.01V | 20mA | less than 1Ω | 50mVp-p |
| 500V | 0 to 600.0V | ±(0.15% + 200mV) | 0.1V | 10mA | less than 5Ω | 100mVp-p |
| 1,000V | 0 to 1,200.0V | ±(0.15% + 200mV) | 0.1V | 5mA | less than 10Ω | 100mVp-p |
| 10μA | 0 to 12.000μA | ±(0.3% + 5nA) | 1nA | 0.25V | approx. 10MΩ | 5nAp-p |
| 50μA | 0 to 60.00μA | ±(0.3% + 20nA) | 10nA | 1.25V | approx. 10MΩ | 10nAp-p |
| 100μA | 0 to 120.00μA | ±(0.3% + 20nA) | 10nA | 2.5V | approx. 10MΩ | 10nAp-p |

**Effect of Temperature Fluctuations:** Within ±10mV/°C on 100V range, within ±100mV/°C on 500V and 1,000V ranges.

**Effect of Power Supply Voltage Fluctuations:** Within ±(0.05% of setting + 0.005% of range)/10V AC.

**Insulation Resistance:** More than 100MΩ at 500V DC

**Dielectric Strength:** 1,500V AC for one minute between case and power line.

*Note: At standard reference conditions of 23±3°C, 40 to 85% relative humidity, and ±5% power supply voltage fluctuation from rated value.

between case and power line.

**Leakage Current:** Less than 0.5mA peak between case and power line at 100V AC.

## CURRENT UNIT

| Range | Output current/ voltage | *Accuracy of output (% of setting) | Resolution | Maximum output (approx.) | Internal resistance (approx.) | Noise (1Hz to 1kHz, typical data) |
|---|---|---|---|---|---|---|
| 1A | 0 to 1.2000A | ±(0.2% + 0.2mA) | 0.1mA | 10V | 5kΩ | 2mAp-p |
| 10A | 0 to 12.000A | ±(0.2% + 2mA) | 1mA | 1V | 500Ω | 20mAp-p |
| 30A | 0 to 36.00A | ±(0.2% + 20mA) | 10mA | 1V | 150Ω | 200mAp-p |
| 100mV | 0 to 120.00mV | ±(0.2% + 0.02mV) | 0.01mV | 10mA | 20mΩ | 20μVp-p |

**Effect of Temperature Fluctuations:** Within ±(0.01% of range)/°C on all except 30A range, within ±(0.03% of range)/°C on 30A range.

**Effect of Power Supply Voltage Fluctuations:** Within ±(0.05% of setting + 0.005% of range)/10V AC.

**Power Consumption:** Approx. 300VA.

**Insulation Resistance:** More than 100MΩ at 500V DC between case and power line.

**Dielectric Strength:** 1,500V AC for one minute between case and power line.

*Note: At standard reference conditions of 23±3°C, 40 to 80% relative humidity, and ±5% power supply voltage fluctuation from rated value.

## OPTION

**General Purpose Interface Bus (GPIB) . . .**
**2560□3, 2560□4**

**Functional, Electrical and Mechanical Specifications:**

Meets the IEEE Standard 488-1975 "Digital Interface for Programmable Instrumentation", interface function and identification . . . SH 1, AH 1, T 5, L 4, SR 1, RL 1, PP O, DC 1, DT 1, C 0.

**Interconnected Devices:** 0 up to 15 maximum.

**Notes:**
1. GPIB should always be ordered together with the standard instrument since the combination instrument will be tested and adjusted at YEW.
2. Interface cable to controller is not provided (must be prepared by user). Example . . . HP Model 10631A, B & C interface cables.

YOKOGAWA ◆

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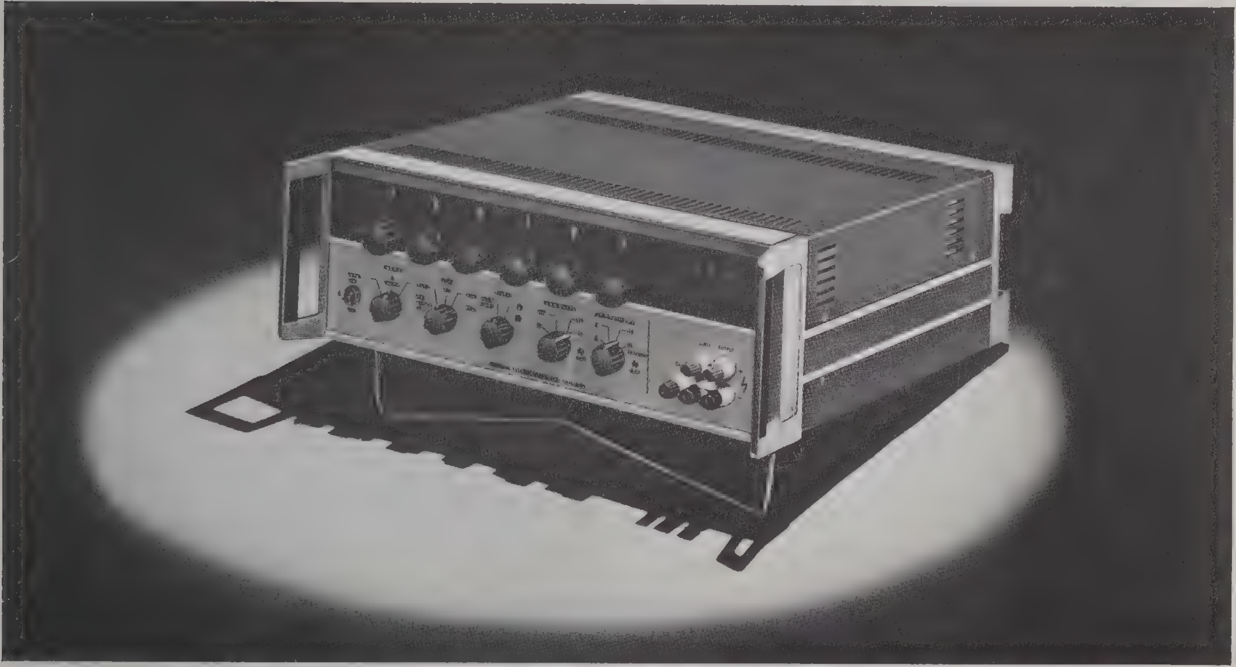
# 2552, 2553, 2554 & 2555
# DC Standards

## 2552 DC VOLTAGE STANDARD



**U.S. Patent 3,636,458*
*(Periodic averaging circuit)*

The YEW Type 2552 is a high-precision, stable DC voltage standard which delivers output voltages from 0 to 1,200 V DC all with an accuracy of ±0.005% of setting. Output voltage can be set by six decade dials on the front panel in four ranges of 1,000 mV, 10V, 100V and 1,000V. Output voltage stability is ±5 ppm per hour, 20 ppm per 30 days, and typical temperature coefficient of output is within 5 ppm of setting per degree Celsius.

Type 2552 uses an entirely new, patented principle, Pulse Width Modulation DC Potentiometer, which was introduced in "IEEE Transactions on Instrumentation and Measurement", Vol. IM-19, No. 4. In this system, output voltage is determined by pulse-width-modulated signal that exactly corresponds to a voltage ratio. Completely different from the conventional voltage divider system DC voltage standards or DC calibrators, PWM DC potentiometer absolutely elimintes error caused by drift of resistor or change of switch contact resistance with time and temperature. As an optional feature, either remote control or BCD output is selectable. All remote control lines are compatible with TTL level and contact signals.

### MAIN FEATURES

- **Patented PWM DC potentiometer of long-life, stable operation**
- **0 to ±1,200V DC in 4 ranges**
  1,000mV/10V/100V/1,000V
- **0 to 36A DC in 7 ranges**
  100 μA/1,000 μA/10 mA/100 mA/1,000 mA/10A/30A with ±0.01% to ±0.2% accuracy (when used with optional current unit)
- **Voltage trip and current limiter**
- **Output setting by digital-coded signal**
  Completely eliminates an unexpected output supply
- **Polarity selection**
- **500 milliseconds settling time**
- **Remote programming/BCD output options**

## SPECIFICATIONS OF 2552

**Output Voltage:** 0 to ±1,199.999 V DC

**Voltage Ranges:**

| Range | Output Voltage | Steps |
|---|---|---|
| 1,000 mV | 0 to ±1,199.999 mV | 1 µV |
| 10 V | 0 to ±11.99999 V | 10 µV |
| 100 V | 0 to ±119.9999 V | 100 µV |
| 1,000 V | 0 to ±1,199.999 V | 1 mV |

**Max. Output Current:** Approx. 25 mA on 1,000mV/10V/100V ranges, approx. 10mA on 1,000V range

**Accuracy of Output:** (for 3-month period, at temperature range of 23±2°C, relative humidity of 45 to 75%, rated power supply voltage and rated load)

1,000mV range (whichever is greater)
±0.005% of setting or ±10µV
10V range (whichever is greater)
±0.005% of setting or ±50 µV
100V range (whichever is greater)
±0.005% of setting or ±500 µV
1,000V range (whichever is greater)
±0.005% of setting or ±5mV

**Temperature Coefficient of Output:** (at temperature range of 5 to 21°C and 25 to 40°C)

1,000mV range; ±(0.0005% of setting + 1 µV)/°C
10V range; ±(0.0005% of setting + 5 µV)/°C
100V range; ±(0.0005% of setting + 50 µV)/°C
1,000V range; ±(0.0005% of setting + 500 µV)/°C

**Stability of Output:** (after 4-hour of OUTPUT ON, at the same conditions described in Accuracy of Output)

1,000mV range (whichever is greater)
(±0.0005% of setting or ±2 µV)/hour
(±0.001% of setting or ±3 µV)/24 hours
(±0.002% of setting or ±5 µV)/30 days
10V range (whichever is greater)
(±0.0005% of setting or ±20 µV)/hour
(±0.001% of setting or ±20 µV)/24 hours
(±0.002% of setting or ±30 µV)/30 days
100V range (whichever is greater)
(±0.0005% of setting or ±200 µV)/hour
(±0.001% of setting or ±200 µV)/24 hours
(±0.002% of setting or ±300 µV)/30 days
1,000V range (whichever is greater)
(±0.0005% of setting or ±2mV)/hour
(±0.001% of setting or ±2mV)/24 hours
(±0.002% of setting or ±3mV)/30 days

**Ripple and Noise:** (at rated output voltage and rated load)

| Range | DC to 10 Hz | 10 Hz to 2 MHz |
|---|---|---|
| 1,000 mV | 5 µVrms | 100 µVrms |
| 10 V | 10 µVrms | 200 µVrms |
| 100 V | 70 µVrms | 500 µVrms |
| 1,000 V | 500 µVrms | 2 mVrms |

**Settling Time:** (time for attaining a value within ±0.005% of final output after change of range or set value except for polarity change)

500 ms on 1,000 mV/10 V/100 V ranges,
3 s on 1,000 V range

**Line Regulation:** (against a ±10% power line voltage change from rated value)

±(0.0005% of setting + 0.0002% of range)

**Load Regulation:** (against a change from no load to full load)

(±0.0005% of setting + 0.0002% of range)

**Common Mode Rejection:**

More than 140 dB at DC,
more than 120dB at 50Hz on 1,000mV/10V/100V ranges,
more than 100dB at 50Hz on 1,000V ranges,
more than 100dB at 1kHz on 1,000mV/10V/100V ranges,
more than 90 dB at 1 kHz on 1,000V range

**Overcurrent Protection (Current Limit):** Automatically limits output current at the preset level from 1 mA to 25 mA in 4 steps by setting of limit dial on the front, Limit ranges; Approx. 1mA/5mA/10mA/25mA on 1,00mV/10V/100V ranges, approx, 1mA/5mA/10mA on 1,000V range

**Overvoltage Protection (Voltage Trip):** Automatically sets output voltage to zero at the preset level, from 12V to 1,200V in 4 steps, output terminals are shorted, and output voltage is turned on only when output dial is set to STAND BY and OUTPUT ON, Ranges; Approx. 12V/120V/600V/1,200V on all ranges

**Polarity Selection:** +, — or 0 (output terminals shortcircuited)

**Operating Temperature Range:** 5 to 40°C (41 to 104°F)

**Storage Temperature Range:** -25 to 70°C (-13 to 158°F)

**Humidity Range:** 20 to 80% (relative humidity)

**Warm-Up Time:** (time for attaining a value within specified accuracy) Approx. one hour

**Insulation Resistance:**

More than 500 MΩ at 500V DC between case and power line, guard and case, and guard and chassis

**Dielectric Strength:** 1,500V rms (50 Hz) for one minute between case and power line, 3,500V rms (50 Hz) for one minute between guard and case, and between guard and chassis

**Power Requirements:** 100, 115, 200, 215 or 230V AC ±10% (must be specified), 47 to 63Hz

**Power Consumption:** Approx. 80VA at full load

**Front Panel Color:** Black (Munsell N1.5/0) and light gray (Munsell N7)

**Dimensions:** Approx. 149 x 439 x 415 mm (5-7/8 x 17-1/4 x 16-3/8")

**Weight:** Approx. 19 kg (41.9 lbs)

**Accessories supplied at no extra cost:**

| | |
|---|---|
| Power cord (2- or 3-prong type) | 1 set |
| Unit mark display lamps | 5 pcs. |
| Fuse (2A or 1A) | 3 pcs. |
| Remote control connector (AMPHENOL 57-30500) | 1 pc. (for 255202 only) |
| BCD output connector (AMPHENOL 57-30500) | 1 pc. (for 255203 only) |
| Instruction manual | 1 copy |

**Types Available:**

| Code | Description |
|---|---|
| **255201** | Standard |
| **255202** | With remote control |
| **255203** | With BCD output |

Note: Both options (remote control and BCD output) are not compatible with a single unit of Type 2552.

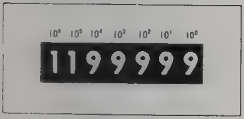
## REMOTE CONTROL (Provided with Code 255202)

Programmable for output voltage, range, polarity, voltage trip, current limit, and stand by/on by external contact signal or TTL level signal. Max. allowable applied voltage between remote control circuit and case is 250Vrms at 50 Hz.

**Remote Control Connector (AMPHENOL 57-40500)**

| Pin No. | | | |
|---|---|---|---|
| 1 | 1 | × $10^0$ | Output Level |
| 2 | 2 | | |
| 3 | 4 | | |
| 4 | 8 | | |
| 5 | 1 | × $10^1$ | |
| 6 | 2 | | |
| 7 | 4 | | |
| 8 | 8 | | |
| 9 | 1 | × $10^2$ | |
| 10 | 2 | | |
| 11 | 4 | | |
| 12 | 8 | | |
| 13 | 1 | × $10^3$ | |
| 14 | 2 | | |
| 15 | 4 | | |
| 16 | 8 | | |
| 17 | 1 | × $10^4$ | |
| 18 | 2 | | |
| 19 | 4 | | |
| 20 | 8 | | |
| 21 | 1 | × $10^5$ | |
| 22 | 2 | | |
| 23 | 4 | | |
| 24 | 8 | | |
| 25 | 1 | × $10^6$ | |

| Pin No. | | |
|---|---|---|
| 26 | — | |
| 27 | — | |
| 28 | — | |
| 29 | — | |
| 30 | — | |
| 31 | — | |
| 32 | Data Strobe | |
| 33 | Remote Enable | |
| 34 | V/C Mode | |
| 35 | A | Range |
| 36 | B | |
| 37 | C | |
| 38 | * Polarity | |
| 39 | RDY/NOT RDY Output | |
| 40 | $C_1$ | **Current Limit |
| 41 | $C_2$ | |
| 42 | $V_1$ | **Voltage Trip |
| 43 | $V_2$ | |
| 44 | Stand BY/ON | |
| 45 | ** Voltage Trip Flag | |
| 46 | — | |
| 47 | **Current Limit Flag | |
| 48 | — | |
| 49 | Common | |
| 50 | + 5 V | |



Notes: *1. Remote control of polarity is not available when Type 2552 is used as current standard by using current unit.

**2. Remote control is available only for Type 2552, and not available when Type 2552 is used as current standard by using current unit.

### Level and Type of Input/Output Circuits

| | Signal Level | Type of Input/Output Circuits |
|---|---|---|
| Input | Level "0" = 0 to + 0.4V or closed contact<br>Level "1" = + 2.4V to + 5.0V or open contact | IC direct (Except for REMOTE ENABLE signal, which is transistor direct) |
| Output | Level "0" = 0 to + 0.5V<br>Level "1" = More than + 2.4V | Transistor direct |

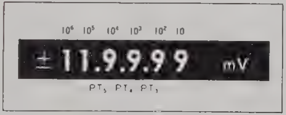
## BCD OUTPUT (Provided with Code 255203)

BCD outputs (output voltage, range, decimal point and unit marks) are available to interface Type 2552 with computer systems or data acquisition systems. Max. allowable applied voltage between BCD output circuit and case is 250 Vrms at 50 Hz.

**BCD Output Connector (AMPHENOL 57-40500)**

| Pin No. | | | |
|---|---|---|---|
| 1 | 1 | × $10^1$ | BCD Output |
| 2 | 2 | | |
| 3 | 4 | | |
| 4 | 8 | | |
| 5 | 1 | × $10^2$ | |
| 6 | 2 | | |
| 7 | 4 | | |
| 8 | 8 | | |
| 9 | 1 | × $10^3$ | |
| 10 | 2 | | |
| 11 | 4 | | |
| 12 | 8 | | |
| 13 | 1 | × $10^4$ | |
| 14 | 2 | | |
| 15 | 4 | | |
| 16 | 8 | | |
| 17 | 1 | × $10^5$ | |
| 18 | 2 | | |
| 19 | 4 | | |
| 20 | 8 | | |
| 21 | 1 | × $10^6$ | |
| 22 | — | | |
| 23 | — | | |
| 24 | — | | |
| 25 | EXT. Hold | | |

| Pin No. | | |
|---|---|---|
| 26 | — | Unit Mark |
| 27 | — | |
| 28 | — | |
| 29 | — | |
| 30 | — | |
| 31 | — | |
| 32 | mA | |
| 33 | A | |
| 34 | mV | |
| 35 | V | |
| 36 | — | |
| 37 | — | |
| 38 | NOT READY Output | |
| 39 | + | Polarity |
| 40 | − | |
| 41 | — | |
| 42 | — | |
| 43 | $PT_3$ | Decimal Point |
| 44 | $PT_4$ | |
| 45 | $PT_5$ | |
| 46 | — | |
| 47 | μA | Unit Mark |
| 48 | — | |
| 49 | Common | |
| 50 | — | |



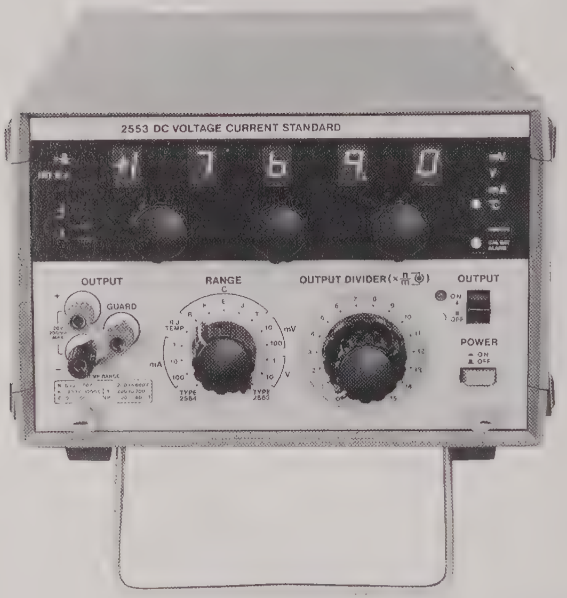
Notes: 1. Both options (BCD output and remote control) are not compatible with a single unit of Type 2552.

2. BCD code of $10^0$ is not available.

### Level and Type of Input/Output Circuit

| | Signal | Level | | Data | Type of Input/ Output Circuits |
|---|---|---|---|---|---|
| | | "0" | "1" | | |
| Output | BCD Output<br>Unit Mark<br>Polarity<br>Decimal Point<br>NOT READY Output | 0 to +0.5V | More than +2.4V | H | TTL IC } direct |
| Input | EXT. Hold | 0 to +0.4V or Clossed Contact | +2.4 to +5.0V or Open Contact | L | |

# 2553 DC VOLTAGE/CURRENT STANDARD



GP·IB

## MAIN FEATURES

- ±0.02% accuracy on all ranges
- 4 voltage ranges, 10mV, 100mV, 1V, 10V; 3 current ranges, 1mA, 10mA, 100mA
- 1μV, 0.1μA resolution
- EMF output for 5 TC types by setting temperature in °C – R, K, E, J, T
- Fractional output divider
- Opto-setting using photocouplers
- Overvoltage and overcurrent protection
- Fully programmable using an optional GPIB

**Types Available:**

| Code | Temperature setting range | Description |
|---|---|---|
| **255341** | JIS or ANSI (°C) | Standard model |
| **255342** | | Standard model with GPIB |
| **255320** | DIN (°C) | Standard model |
| **255321** | | Standard model with GPIB |

Type 2553 is an ultra-stable, high-resolution DC voltage and current source which delivers output voltages from 1μV to 12V, and output currents from 0.1μA to 120mA at an accuracy of ± 0.02%.

Output voltage and current are set using three dials on the front panel. Settings are controlled by digital signals passing through photocouplers and microprocessors, and are displayed on a red 5-digit LED.

## OPTION

**General Purpose Interface Bus(GPIB) . . . Type 255342 or 255321**

**Functional, Electrical and Mechanical Specifications:**
Meets IEEE Standard 488-1975 "Digital Interface for Programmable Instrumentation", interface function and identification . . . SH 1, AH 1, T 6, L 4, SR 1, RL 1, PP 0, DC 1, DT 1, C 0.

**Interconnected Devices:** 0 up to 15 maximum.

Notes: 1. GPIB should always be ordered together with the standard instrument since the combination instrument will be tested and adjusted at YEW.

2. Interface cable to controller is not provided (must be prepared by user).
Examples . . . HP Model 10631A, B & C interface cables.

## OPTIONAL ACCESSORY

**Code 257825 Semiconductor Probe**
**Measuring Range:** –20 to 60°C.
**Accuracy:** ±0.3°C (with Type 2553).
**Insulation Resistance:** More than 100MΩ at 500V DC between terminal tips and Type 2553 ground terminal.
**Dielectric Strength:** 100V AC for one minute between terminal tips and Type 2553 ground terminal.
**Cord Length:** Approx. 2m (6.6 ft).
**Terminal Material:** Copper.
**Accessories Supplied:** Round tips . . . 5 pcs.

## SPECIFICATIONS

**Output Voltage/Current Ranges and Accuracy of Output:**

| Range | Output voltage/ current | Reso- lution | Accuracy of output (at 23 ± 3°C) |
|---|---|---|---|
| 10V | 0 to ±12.000V | 1mV | ±0.02% of range |
| 1V | 0 to ±1.2000V | 100μV | ±0.02% of range |
| 100mV | 0 to ±120.00mV | 10μV | ±0.02% of range |
| 10mV | 0 to ± 12.000mV | 1μV | ± (0.02% of range +4μV) |
| 100mA | 0 to ±120.00mA | 10μA | ±0.02% of range |
| 10mA | 0 to ±12.000mA | 1μA | ±0.02% of range |
| 1mA | 0 to ±1.2000mA | 0.1μA | ±0.02% of range |

**Maximum Output and Internal Resistance:**

| Range | Maximum output (approx.) | Internal resistance (approx.) |
|---|---|---|
| 10V | 120mA | Less than 10mΩ |
| 1V | 120mA | Less than 10mΩ |
| 100mV | * 1kΩ | 1Ω |
| 10mV | * 1kΩ | 1Ω |
| 100mA | 15V (0 to 50mA) | 1MΩ |
|  | 9V (50 to 100mA) | 1MΩ |
| 10mA | 15V | 10MΩ |
| 1mA | 15V | 10MΩ |

* Note: Minimum load resistance for –0.1% error.

**Output Setting:** 3 dials on the front panel (opto-setting using photocouplers without mechanical contacts),
1st and 2nd dials . . . 16 steps, 3rd (lowest digit) dial . . . 32 steps.

**Setting Value Indication:** Red 5-digit LED display.

**Output Unit Marks:** mV, V, mA or °C.

**OUTPUT DIVIDER:**
DIVIDER output = output setting × $\frac{n}{m}$, m and n are selectable by OUTPUT DIVIDER dual-dial,
m . . . 1, 2 through 15 in 15 uniform divisions,
n . . . 0, 1 through 15 ($n \leqq m$).

**Accuracy of Output Divider:** Within ± 1 digit of LSD.

**Temperature Coefficient:** 50 ppm/°C at 5 to 40°C.

**Calibration Cycle:** 3 months.

**Ripple:** Less than ± 0.01% of setting range on 100mV, 1V, 10V, 10mA, 100mA ranges (for DC to 60Hz components), less than ± 0.05% of setting range on 1mA range.

**Common Mode Rejection (DC to 60Hz):** Approx. 120dB for voltage output, approx. 0.1μA/V for current output.

**Effect of Power Supply Voltage Fluctuation:** Within ± 0.02% of range against ± 10% fluctuation in rated value.

**Overcurrent Protection:** Automatically limits output current at approx. 120mA.

**Overvoltage Protection:** Automatically sets output voltage to zero at approx. 15V.

**Polarity Selection:** + or –.

**Insulation Resistance:** More than 100MΩ at 500V DC between case and guard, and between power line and case.

**Dielectric Strength:** 1,500V AC for one minute between power line and case, 100V AC for one minute between case and guard.

**Operating Temperature Range:** 5 to 40°C (41 to 104°F).

**Humidity Range:** 5 to 95% relative humidity.

**Warmup Time:** Approx. 30 minutes.

**Power Requirements:** 100, 120, 200, 220 or 240V AC ± 10% (must be specified), 50 and 60Hz.

**Power Consumption:** 50VA max.

**Dimensions:** Approx. 149 x 233 x 364mm (5-7/8 x 9-1/4 x 14-3/8").

**Weight:** Approx. 8.0kg (17.6 lbs).

**Accessories supplied at no extra cost:**
Power cord (2- or 3-prong type) . . . 1 set, fuses . . . 2 pcs.

**Temperature Setting Ranges:**

| Model | TC Type (RANGE) | Setting range (EMF output) | Accuracy (at 23 ± 3°C) |  | Resolution (approx.) | Internal resistance (approx.) |
|---|---|---|---|---|---|---|
|  |  |  | At 25°C x n setting (n: positive integer) | At setting other than 25°C x n |  |  |
| JIS or ANSI (°C), **25534** ☐ | R | 0 to 1,768°C | ±2.76°C | ±3.26°C | 1°C | 1Ω |
|  | K | –200 to 1,200°C | ±0.40°C<br>*±0.94°C | ±0.47°C<br>*±1.17°C | 0.1°C | 1Ω |
|  | E | 0 to 700°C | ±0.25°C | ±0.31°C | 0.1°C | 1Ω |
|  | J | –200.0 to 600.0°C | ±0.37°C<br>*±0.68°C | ±0.44°C<br>*±0.90°C | 0.1°C | 1Ω |
|  | T | –200.0 to 200.0°C | ±0.20°C<br>*±0.35°C | ±0.25°C<br>*±0.50°C | 0.1°C | 1Ω |
| DIN(°C), **25532** ☐ | PtRh-Pt | 0 to 1,600°C | ±2.73°C |  | 1°C | 1Ω |
|  | NiCr-Ni | 0 to 1,200°C | ±0.40°C |  | 0.1°C | 1Ω |
|  | Fe-Konst | –200.0 to 600.0°C | ±0.37°C<br>*±0.69°C |  | 0.1°C | 1Ω |
|  | Cu-Konst | –200.0 to 200.0°C | ±0.20°C<br>*±0.4°C |  | 0.1°C | 1Ω |
|  | NiCr-Konst | 0 to 700°C | ±0.35°C |  | 0.1°C | 1Ω |

Notes:
*1. At setting of below 0°C.
2. Compensation accuracy when used with an optional semiconductor probe:
±0.38°C (±0.76°C for R) in 0 to 50°C measuring range.
3. Accuracy of DIN model is at 50°C.

# 2554 DC VOLTAGE/CURRENT STANDARD

The highly reliable Type 2554 is a combination of ±0.05% voltage and current standards, which is packed into a compact, rugged case, and both line- and battery-operated. Rechargeable battery operation makes the instrument truly portable and completely isolated from the power line. The rechargealble battery included in this instrument operates for a continuous three hours at full load after recharge.

This new instrument delivers output voltages from 0 to ±120V in 5 ranges, and output currents from 0 to ±120mA in 3 ranges with a setting accuracy of ±0.05%. Different from other battery-operated DC standards of this class, Type 2554 provides a 100V range, and furnishes maximum output of 15V (up to 50mA) on 100mA range. Other nifty functions include polarity reversal selector, over-current and -voltage protection, and fast, exact operation through dial- and paddle-operated switches on the front.

Type 2554 is also usable for precision temperature measurement by employing an optional combination unit of Reference Junction Compensator.

## MAIN FEATURES

- **±0.05% accuracy**
- **5 voltage ranges, 3 current ranges 100V/10V/1V/100mV/10mV, 100mA/10mA/1mA**
- **1$\mu$V, 0.1$\mu$A resolution**
- **Compact, easily portable**
- **Over-voltage and over-current protection**
- **Polarity selection**
- **Rechargeable Ni-Cd battery/power line operation**
- **Easy-to-read in-line display**
- **Rapid paddle switch operation**
- **Reference junction compensator (optional)**

## OPTIONAL COMBINATION UNIT

### 2562 Reference junction compensator

Type 2562 is used with Type 2554 for precision temperature measurement, measurement of thermocouple characteristics, and calibration of thermocouple thermometers. By operation of turn-counting dial from the front, Type 2562 supplies the emf value corresponding to the room temperature obtained from standard emf table for thermocouples.

**Voltage Setting Range:** 0 to –3mV, 2$\mu$V/div. (in combination with Type 2554, temperature below 0°C cannot be measured).

**Setting Dial:** Turn-counting potentiometer (3-digit numerals and vernier scale with digital readout angled to the perpendicular for easy viewing).

**Accuracy:** (at temperature of 23±2°C, and relative humidity of 45 to 75%) ±18$\mu$V.

**Temperature Coefficient:** (at temperature range of 5 to 45°C) ±0.3$\mu$V/°C.

**Dimensions:** Approx. 45 x 90 x 45mm (1-3/4 x 3-1/2 x 1-3/4'').

**Weight:** Approx. 0.2kg (0.4 lbs).

**Accessory supplied at no extra cost:** Standard emf table for thermocouples (R, K, J, T, E) . . . . . . . . 1 sheet.

*Type 2562 combined with Type 2554*

## SPECIFICATIONS

**Output Ranges and Steps:**

| Range | Output Voltage/Current | Steps |
|---|---|---|
| 100V | 0 to ±119.99V | 10mV |
| 10V | 0 to ±11.999V | 1mV |
| 1V | 0 to ±1.1999V | 100µV |
| 100mV | 0 to ±119.99mV | 10µV |
| 10mV | 0 to ±11.999mV | 1µV |
| 100mA | 0 to ±119.99mA | 10µA |
| 10mA | 0 to ±11.999mA | 1µA |
| 1mA | 0 to ±1.1999mA | 0.1µA |

**Accuracy of Output:** (at temperature range of 23±2°C, relative humidity of 45 to 75%, rated power supply voltage and 6-month calibration cycle)

| Range | Accuracy of Output |
|---|---|
| 100V | ±(0.05% of setting + 10mV) |
| 10V | ±(0.05% of setting + 1mV) |
| 1V | ±(0.05% of setting + 100µV) |
| 100mV | ±(0.05% of setting + 10µV) |
| 10mV | ±(0.05% of setting + 2µV) |
| 100mA | ±(0.05% of setting + 10µA) |
| 10mA | ±(0.05% of setting + 1µA) |
| 1mA | ±(0.05% of setting + 0.1µA) |

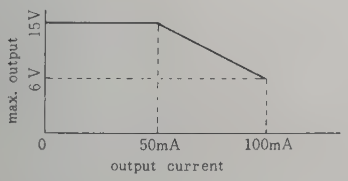
**Settling Time:** Time for attaining a value within ±(0.05% of setting + 0.01% of range)

| Output | Settling Time | Range |
|---|---|---|
| Step-up | Less than 0.1 second | 100mV/10mV |
| | Approx. 1 second | 10V, 10mA/1mA |
| | Approx. 1.5 seconds | 100V, 100mA |
| Step-down | Less than 0.1 second | 100mV/10mV |
| | Approx. 2 seconds | 10V, 100mA/1mA |
| | Approx. 1 second | 100mA |
| | Approx. 4.5 seconds | 100V |

**Maximum Output and Internal Resistance:**

| Range | Max. Output | Internal Resistance |
|---|---|---|
| 100V | 1mA | Less than 100mΩ |
| 10V | 10mA | Less than 50mΩ |
| 1V | 10mA | Less than 30mΩ |
| 100mV | * 2kΩ | Less than 2Ω |
| 10mV | * 2kΩ | Less than 2Ω |
| 100mA | ** 6V | Approx. more than 1MΩ |
| 10mA | 15V | Approx. more than 3MΩ |
| 1mA | 15V | Approx. more than 30MΩ |

Notes: *1. Minimum load resistance for –0.1% error.
**2. Max. output on 100mA range is as follows:



**Temperature Coefficient of Output:** ±(0.005% of setting + 0.0005% of range)/°C at 5 to 21°C, or 25 to 40°C.

**Warm-Up Time:** 5 minutes after power supply selector turned on.

**Effect of Power Source Voltage Fluctuation:** ±(0.01% of setting + 0.005% of range) against ±10% fluctuation of AC power supply voltage, or DC power source change from 9.6V to 8V.

**Stability:** (Stability apply at constant conditions)
±(0.001% of setting + 0.0005% of range)/hour
±(0.005% of setting + 0.001% of range)/day
±(0.015% of setting + 0.003% of range)/month

**Output Polarity:** + or – selected by flip switch.

**Noise:**

| Range | Noise (DC to 1MHz) |
|---|---|
| 100V | Less than 10mVp-p |
| 10V | Less than 1mVp-p |
| 1V | Less than 0.5mVp-p |
| 100mV | Less than 50µVp-p |
| 10mV | Less than 10µVp-p |
| 100mA | Less than 45µAp-p |
| 10mA | Less than 3µAp-p |
| 1mA | Less than 0.3µAp-p |

**Overcurrent and Overvoltage Protection:**

| Range | *Limit Level | **Alarm Level |
|---|---|---|
| 10mV | Not operated | Not operated |
| 100mV | | |
| 1V | Approx. 100mA | Approx. 13mA±10% |
| 10V | Approx. 100mA | Approx. 13mA±10% |
| 100V | Approx. 100mA | Approx. 1.3mA±10% |
| 1mA | Approx. 16V | Approx. 16V |
| 10mA | | |
| 100mA | | |

Notes: *1. Limit level: Automatically limits output current (or voltage) at the level shown above.
**2. Alarm level: OVER A (or OVER V) lamp lights up at the level shown above.

**Dielectric Strength:** 1,500V AC for one minute between case and power line, 1,250V AC between case and output terminals.

**Insulation Resistance:** 100MΩ at 500V DC between case and power line.

**Operating Temperature Range:** 5 to 40°C (41 to 104°F)

**Humidity Range:** 20 to 80% (relative humidity)

**Power Requirements:** 100, 115, 120, 200, 215, 220, 230 or 240V AC (must be specified), or 8V DC (nickel-cadmium battery).

**DC Power Source:** 8V DC rechargeable nickel-cadmium battery (built in), Recharging time; approx. 15 hours, Continuous operating time: approx. 3 hours at full load.

**Power Consumption:** Approx. 8VA at maximum load, approx. 15VA under battery recharging

**Dimensions:** Approx. 100 x 210 x 230mm (4-3/8 x 8-1/4 x 9-1/8").

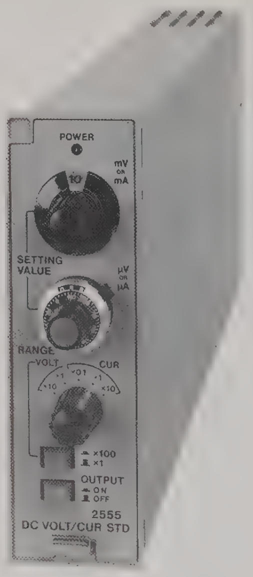
**Weight:** Approx. 4.0kg (8.8 lbs).

**Accessories supplied at no extra cost:**
Power cord (1 set), Fuses (1A, 2pcs), A9017ED(289905) Rechargeable Nickel-Cadmium Battery (1 pc.).

# 2555 DC VOLTAGE/CURRENT STANDARD

Type 2555 is a compact, highly stable DC source which delivers output voltage from 0 to 11V in 4 ranges, and output current from 0 to 110mA in 3 ranges with a setting accuracy of ±0.1% or ±0.2%.

When combined with a high-sensitivity recorder or DC amplifier, Type 2555 allows cancellation of DC levels superimposed on the input signal. This function is convenient for expanded-scale recording of DC-superimposed, small-amplitude signals. Output voltage or current is set by means of two dials and a 10-turn potentiometer.



## SPECIFICATIONS

**Output Ranges, Accuracy of Output, and Steps:**

| Range | Output Voltage/ Current | *Accuracy of Output (% of setting) | Steps |
|---|---|---|---|
| 10V | 0 to 11V | ±(0.1% + 10mV) | 2mV |
| 1V | 0 to 1.1V | ±(0.1% + 1mV) | 200μV |
| 100mV | 0 to 110mV | ±(0.1% + 100μV) | 20μV |
| 10mV | 0 to 11mV | ±(0.1% + 10μV) | 2μV |
| 100mA | 0 to 110mA | ±(0.2% + 100μA) | 20μA |
| 10mA | 0 to 11mA | ±(0.2% + 10μA) | 2μA |
| 1mA | 0 to 1.1mA | ±(0.2% + 1μA) | 200nA |

* At temperature range of 23 ±3°C.

**Temperature Coefficient of Output:** ±0.006% of range/°C at 5 to 20°C, or 26 to 40°C.

**Warm-Up Time:** Approx. 20 minutes (to attain values within specified accuracy).

**Internal Resistance, Maximum Output, and Ripple:**

| Range | Internal Resistance (approx.) | Max. Output | Ripple |
|---|---|---|---|
| 10V | 500mΩ | 100mA | Within 100μV pk-pk |
| 1V | 500mΩ | 100mA | Within 100μV pk-pk |
| 100mV | 10 Ω | | Within 10μV pk-pk |
| 10mV | 10 Ω | | Within 10μV pk-pk |
| 100mA | $10^6$ Ω | 10V | Within 10μA pk-pk |
| 10mA | $10^7$ Ω | 10V | Within 1μA pk-pk |
| 1mA | $10^7$ Ω | 10V | Within 0.1μA pk-pk |

**Common Mode Rejection:** Approx. 120dB on voltage ranges at DC to 60Hz, approx. 0.1μA/V on current ranges.

**Effect of Power Supply Voltage Fluctuations:** Within ±0.01% of range against ±10% fluctuation from rated power supply voltage.

**Dielectric Strength:** 1,500V AC for one minute between case and power line, 100V AC for one minute between case and guard.

**Insulation Resistance:** More than 100MΩ at 500V DC between case and power line, or between case and guard.

**Leakage Current:** Within 0.5mA peak between case and power line at 100V AC line voltage.

**Operating Temperature Range:** 5 to 40°C (41 to 104°F).

**Operating Humidity Range:** 20 to 80%, relative humidity.

**Storage Temperature Range:** –25 to 70°C (–13 to 158°F).

**Storage Humidity Range:** 5 to 100%, relative humidity (non-condensing at 100%)

**Power Requirements:** 100, 120, 200, 220 or 240V AC ± 10% (must be specified), 48 to 63 Hz.

**Power Consumption:** 8VA max. at no load, 10VA max. at full load.

**Dimensions:** Approx. 138 x 42 x 374mm (5-1/2 x 1-5/8 x 14-3/4'').

**Weight:** Approx. 2.2kg (4.9 lbs).

**Accessories supplied at no extra cost:** Power cord (2- or 3-prong type) . . . 1 set, fuse (0.2A) . . . 1 pc.

YOKOGAWA ◆

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05

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Printed in Japan, Feb. 1990(C)/(YG)

# 2558
# AC Voltage/Current Standard

## 0.08% Precision AC Voltage and Current Source .....
## Fully Programmable Using an Optional IEEE Interface

GP·IB

Type 2558 is a precision, stable AC voltage and current source, providing 6 voltage ranges, 100mV to 1,000V, and 4 current ranges, 100mA to 50A. It has the accuracies to ±0.08%, and maximum output level is 30V on the 100mA range, and 0.5A on the 1V range.

Output voltage or current set using front-panel dials are controlled by digital signals through photocouplers and microprocessors, and displayed on a red 5-digit LED. This optical output control system completely eliminates mechanical switch failures and ensures long-term, reliable operation. The standard model features many versatile functions, all of which are front panel controlled.

Using an optional General Purpose Interface Bus (GPIB) that meets the IEEE 488 Standard, all functions are remotely programmed and controlled through rear-panel connectors. This function enables Type 2558 to be interfaced easily with other instruments or to be applied in a fully automatic calibration or test system.

## MAIN FEATURES

- **±0.08% accuracy**
  Basic output accuracy is ±0.08% of setting at 50 or 60Hz on all except 50A range.
- **1mV to 1,200V in 6 ranges, 1mA to 60A in 4 ranges**
- **Frequency ranges — 50, 60, 400Hz or 40 to 500Hz continuously variable**
  External oscillator can also be used on 40 to 800Hz frequency ranges.
- **Overvoltage and overcurrent protection**
- **Bright, clear red LED readout**
- **Sweep mode**
  Outputs are automatically and continuously variable from 0 to 100% of setting, or 100% to 0 in about 16 seconds. This function is especially valuable for friction test of indicating instruments.
- **Large output capacity — 30V max. on 100mA range, 0.5A max. on 1V range**
- **% deviation readout**
  Calibration error is directly displayed in percent of setting on 3-digit LED. This function completely eliminates cumbersome, time-consuming calculations.
- **Output divider**
  Any voltage and current setting can be divided into 1 to 15 uniform divisions, providing quick and simple calibration, testing or adjustment.
- **Remote control and programming using IEEE-488 interface (optional)**
  Type 2558 is remotely controllable, and programmable by IEEE Standard 488-1975 interface.

## SPECIFICATIONS

**Output:**

| Range | *Output | Resolution | Maximum Output (approx.) |
|---|---|---|---|
| 100mV | 1.00 to 120.00mV | 10$\mu$V | 10$\Omega$(output resistance) |
| 1V | 0.0100 to 1.2000V | 100$\mu$V | 0.5A |
| 10V | 0.100 to 12.000V | 1mV | 3A |
| 100V | 1.00 to 120.00V | 10mV | 0.3A |
| 300V | 3.0 to 360.0V | 100mV | 0.1A |
| 1,000V | 10.0 to 1,200.0V | 100mV | 6mA |
| 100mA | 1.00 to 120.00mA | 10$\mu$A | 30V |
| 1A | 0.0100 to 1.2000A | 100$\mu$A | 30V |
| 10A | 0.100 to 12.000A | 1mA | 3V |
| 50A | 0.50 to 60.00A | 10mA | 0.6V |

* May be set to zero with settings of less than 1% of range.

**Accuracy:** 50 or 60Hz . . . ±(0.08% of setting + 0.015% of range) on all except 50A range,
±(0.15% of setting + 0.015% of range) on 50A range,
400Hz . . . ±(0.1% of setting + 0.015% of range) on all except 50A range,
±(0.2% of setting + 0.015% of range) on 50A range.
Note Output at less than 20% of range,
50 or 60Hz . . . ±0.02% of range on all except 50A range,
±0.04% of range on 50A range,
400Hz . . . ±0.03% of range on all except 50A range,
±0.06% of range on 50A range.

**Distortion:** Voltage output . . . 0.07% of range, current output . . . 0.18% of range, at output from 40 to 120% of range.

***Above accuracies and distortion apply at the following reference standard conditions:***
Output frequency . . . 50, 60 or 400Hz generated by internal oscillator, ambient temperature . . . 23±3°C, humidity range . . . less than 75% relative humidity, power supply voltage fluctuation . . . within ±10% of rated value, load . . . less than 6VA on all except 1,000V and 100mA ranges, less than 1.2VA on 1,000V range, less than 0.2VA on 100mA range.

**Output Voltage/Current Setting:** 4 dials on the front panel (opto-setting using photocouplers without mechanical contacts), highest dial . . . 0 to 12 in 13 steps, 3 least dials . . . 0 to 9 in 10 steps.

**Setting Value Indication:** 5-digit red LED display.

**Output Unit Marks:** mV, V, mA or A.

**DIVIDER Output:**
DIVIDER output = output V/A setting $\times \frac{n}{m}$, m and n are selectable by OUTPUT DIVIDER dual-in-one dial, m . . . 1, 2 through 15 in 15 uniform divisions, n . . . 0, 1 through 15 ($n \leqq m$).

**Accuracy of Output Divider:** Within ±1 digit of LSD.

**Stability:** ±0.03% of range/hour.

**Calibration Cycle:** 3 months.

**% DEVIATION Setting:** 2 dials on the front panel (opto-setting using photocouplers), up to 9.99% of output setting.

**% DEVIATION Indication:** 3-digit LED display up to 9.99% indication.

**SWEEP Speed:** Approx. 16 seconds for sweep from 0 to 100% of setting or 100% to 0.

**Frequency Range (Sine Wave):** Internal oscillator . . . 50Hz ± 1%, 60Hz ± 1%, 400Hz ± 1%, or 40 to 500Hz continuously variable using FREQUENCY dual dial (temperature coefficient of internal oscillator . . . 0.02Hz/°C on 50 or 60Hz range, 0.1Hz/°C on 400Hz range), external oscillator . . . 40 to 800Hz (3±0.1V, input impedance approx. 10k$\Omega$)

**Output Frequency Indication:** 4-digit LED display (indication accuracy . . . ±0.1Hz on 40 to 100Hz, ±0.2Hz on 100 to 500Hz, ±0.6Hz on 500 to 800Hz).

**Response Time:** Approx. 3 seconds for output of 0 to 100% of setting.

**Temperature Coefficient of Output:** ±50ppm of range/°C at 5 to 20°C, 26 to 40°C.

**Output Terminal:** Grounded.

**Insulation Resistance:** More than 100M$\Omega$ at 500V DC between power line and output terminals, and between power line and case.

**Dielectric Strength:** 1,500V AC for one minute between power line and output terminals, and between power line and case.

**Power Requirements:** 100, 120, 200, 220 or 240V AC ± 10% (must be specified), 50 and 60Hz.

**Power Consumption:** Approx. 200VA.

**Front Panel Color:** Black and green yellow.

**Dimensions:** Approx. 149 x 439 x 415mm (5-7/8 x 17-1/4 x 16-3/8").

**Weight:** Approx. 23kg (50.7 lbs).

**Accessories supplied at no extra cost:**
Power cord (2- or 3-prong type) . . . 1 set, output cord (for large current) . . . 2 pcs., fuses (2A, time lag type) . . . 2 pcs.

## OPTION

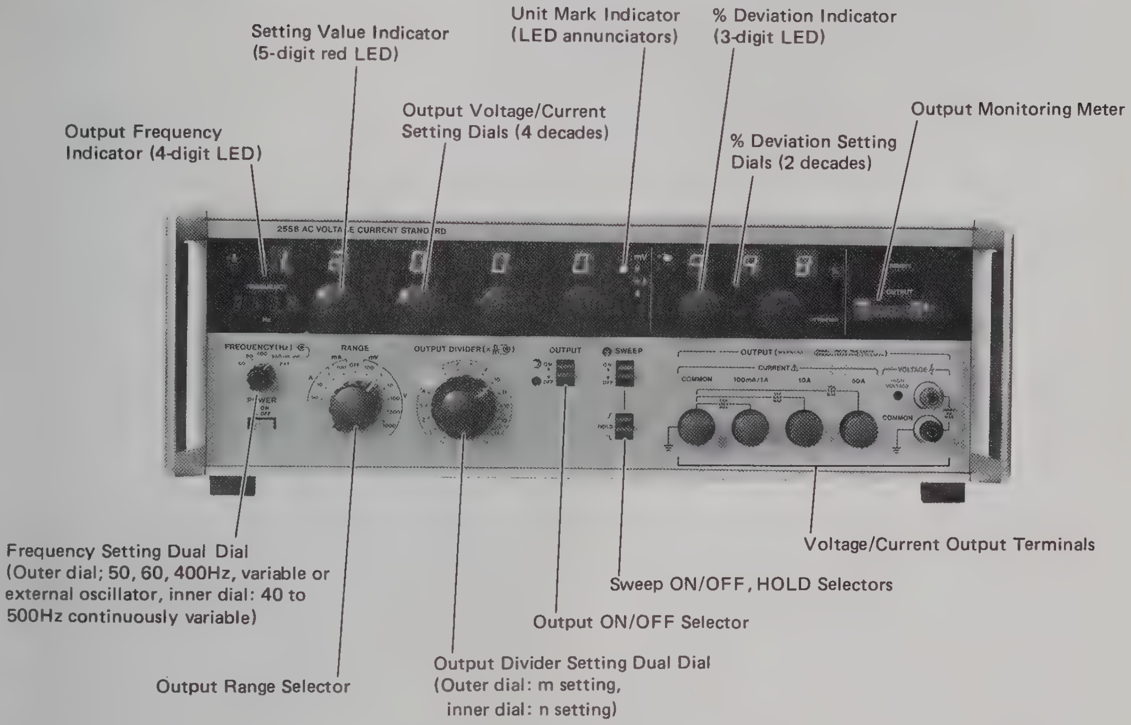
**General Purpose Interface Bus (GPIB) . . . Model 255801**

**Functional, Electrical and Mechanical Specifications:**
Meets the IEEE Standard 488-1975 "Digital Interface for Programmable Instrumentation", interface function and identification . . . SH 1, AH 1, T 5, L 4, SR 1, RL 1, PP 0, DC 1, DT 1, C 0.

**Interconnected Devices:** 0 up to 15 maximum.

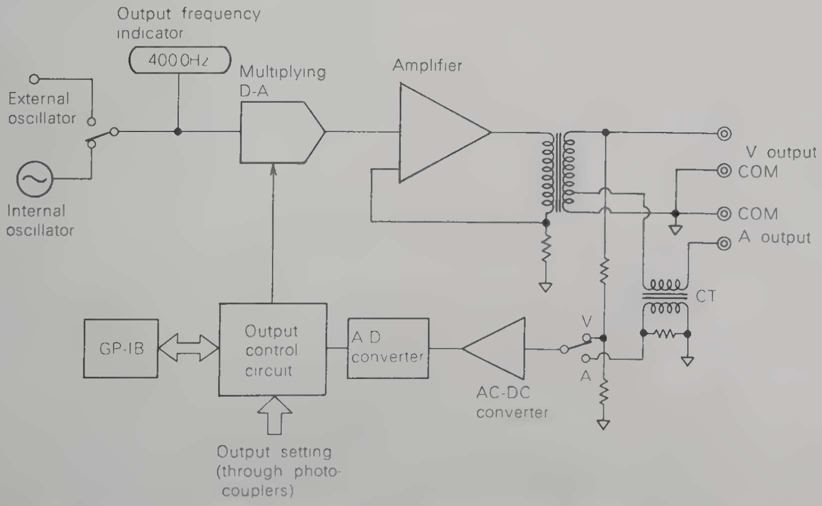
Notes:
1. GPIB should always be ordered together with the standard instrument since the combination instrument will be tested at YEW.
2. Interface cable to controller is not provided with Type 255801 (must be prepared by user). Examples . . . HP Model 10631A, B & C interface cables.

## PANEL LAYOUT


Setting Value Indicator (5-digit red LED)
Unit Mark Indicator (LED annunciators)
% Deviation Indicator (3-digit LED)
Output Frequency Indicator (4-digit LED)
Output Voltage/Current Setting Dials (4 decades)
% Deviation Setting Dials (2 decades)
Output Monitoring Meter
Frequency Setting Dual Dial (Outer dial; 50, 60, 400Hz, variable or external oscillator, inner dial: 40 to 500Hz continuously variable)
Voltage/Current Output Terminals
Sweep ON/OFF, HOLD Selectors
Output ON/OFF Selector
Output Divider Setting Dual Dial (Outer dial: m setting, inner dial: n setting)
Output Range Selector

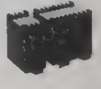
*Connectors for auxiliary output and external frequency input (remote control and GP-IB, optional) are provided on the rear panel.

## SIMPLIFIED BLOCK DIAGRAM



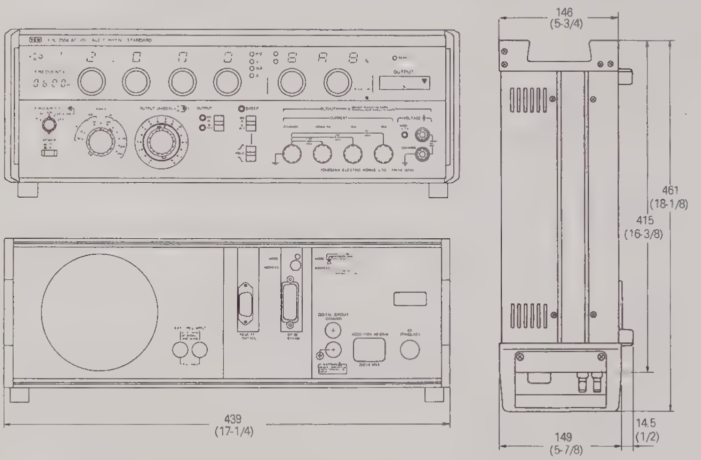
## EXAMPLES OF APPLICATIONS

- For calibration of AC indicating and measuring instruments including DMM's.
- For test and calibration of transducers.
- For testing AC machines.
- For testing electronic components.
- For testing and calibrating aircraft instruments and parts, and others.
- As a system component using optional GPIB, for automated test or calibration systems.



## DIMENSIONS

Unit: mm (approx. inch)



### Ordering Information

When ordering or requesting quotations, specify:

1. Instrument name and type number (basic instrument . . . Type 255800, basic instrument with optional GPIB . . . Type 255801).
2. Power supply voltage.

YOKOGAWA ◆

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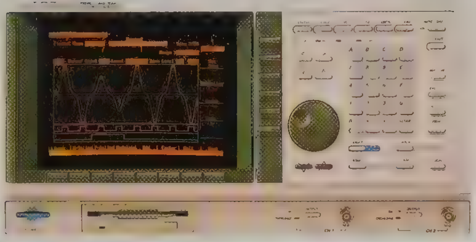
YOKOGAWA

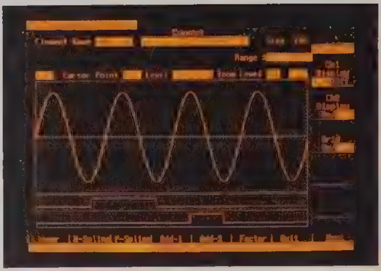
The YOKOGAWA AG2000 Series is a new lineup of arbitrary waveform generators, which generate one- or two-channel arbitrary waveforms. AG2000 ranges DC to 50 MHz or 100 MHz with clock rate of 100 MHz or 200 MHz max. (1Hz resolution), and 10-bit or 8-bit D-A conversion. AG2000 incorporates many easy-to-use features such as large memory (128k words/channel), 9" CRT, and simple menu setting. Complex waveforms can be created by using Mathematical Fomulas or "Scope Draw". Waveforms captured by other instruments can be downloaded directly into the AG2000 via its GPIB interface.

# AG

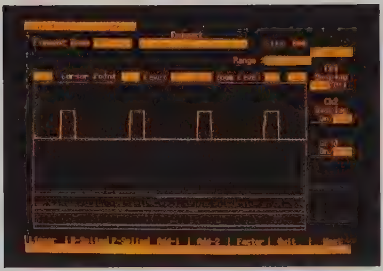
# Arbitrary Waveform Generator



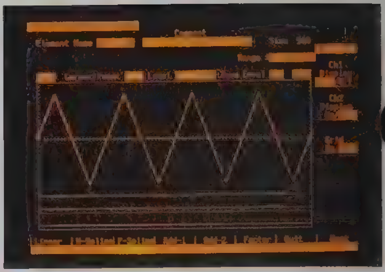
## 2000 Series



Sine



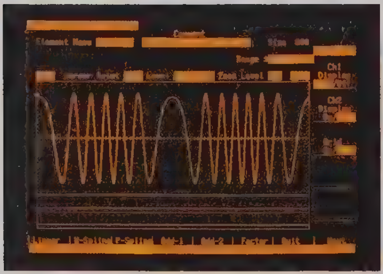
Pulse train



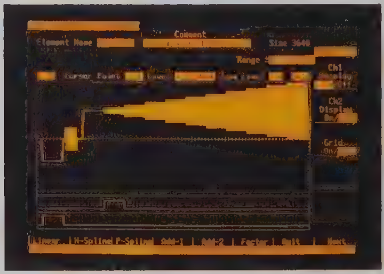
Triangle

# Arbitrary Waveform Generator
# AG2000 Series

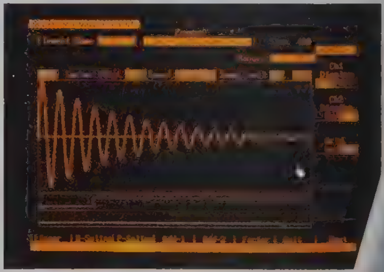
In the development of high-tech equipment, there is an ever increasing need for simulation of complex, high-speed, wide bandwidth waveforms such as ones filled with noise, distorted by harmonics, or of a specific modulation. However, up until now, it has been virtually impossible to obtain a waveform just like the one you have in mind. But...now, YOKOGAWA has developed an arbitrary waveform generator, the AG2000 Series, which has overcome this difficulty and can produce any desired waveform. The AG2000's unique features are made possible by a variety of original functions designed by YOKOGAWA.



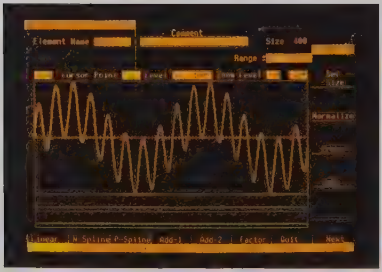
FM



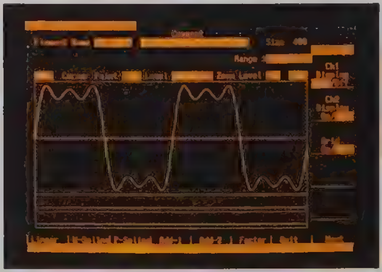
Video signal



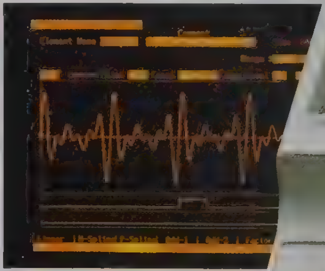
Damped sine wave



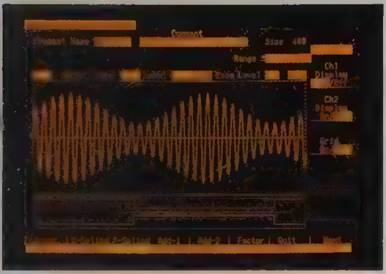
Summed sine wave

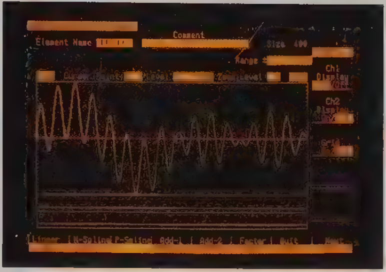


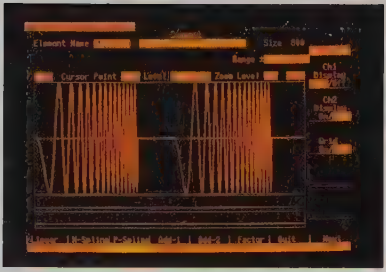
With 3rd & 5th order harmonics

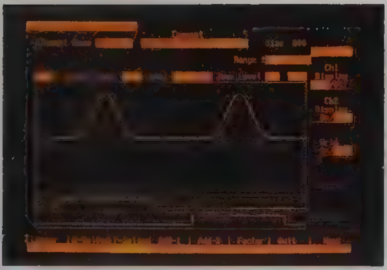


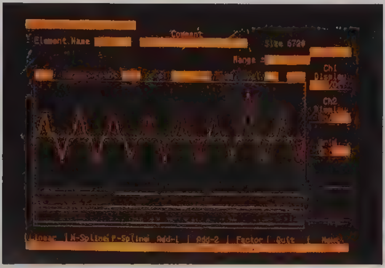
Multitone signal

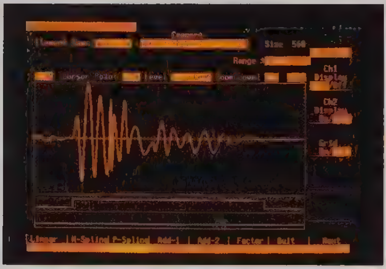



Element Name
Comment
Size 400
Range
Zoom Level
Ch1 Display
Ch2 Display
Linear | N-Spline | P-Spline | Add-1 | Add-2 | Factor | Quit | Next

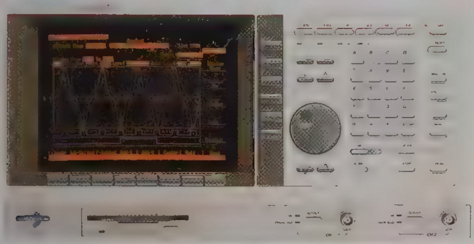




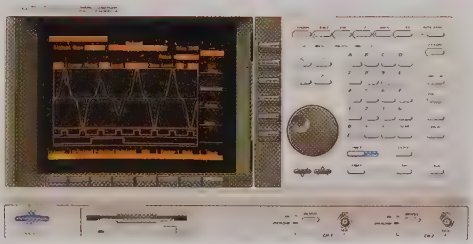

Element Name
Comment
Size 5720
Range
Ch1 Display
Ch2 Display
Linear | N-Spline | P-Spline | Add-1 | Add-2 | Factor | Quit | Next

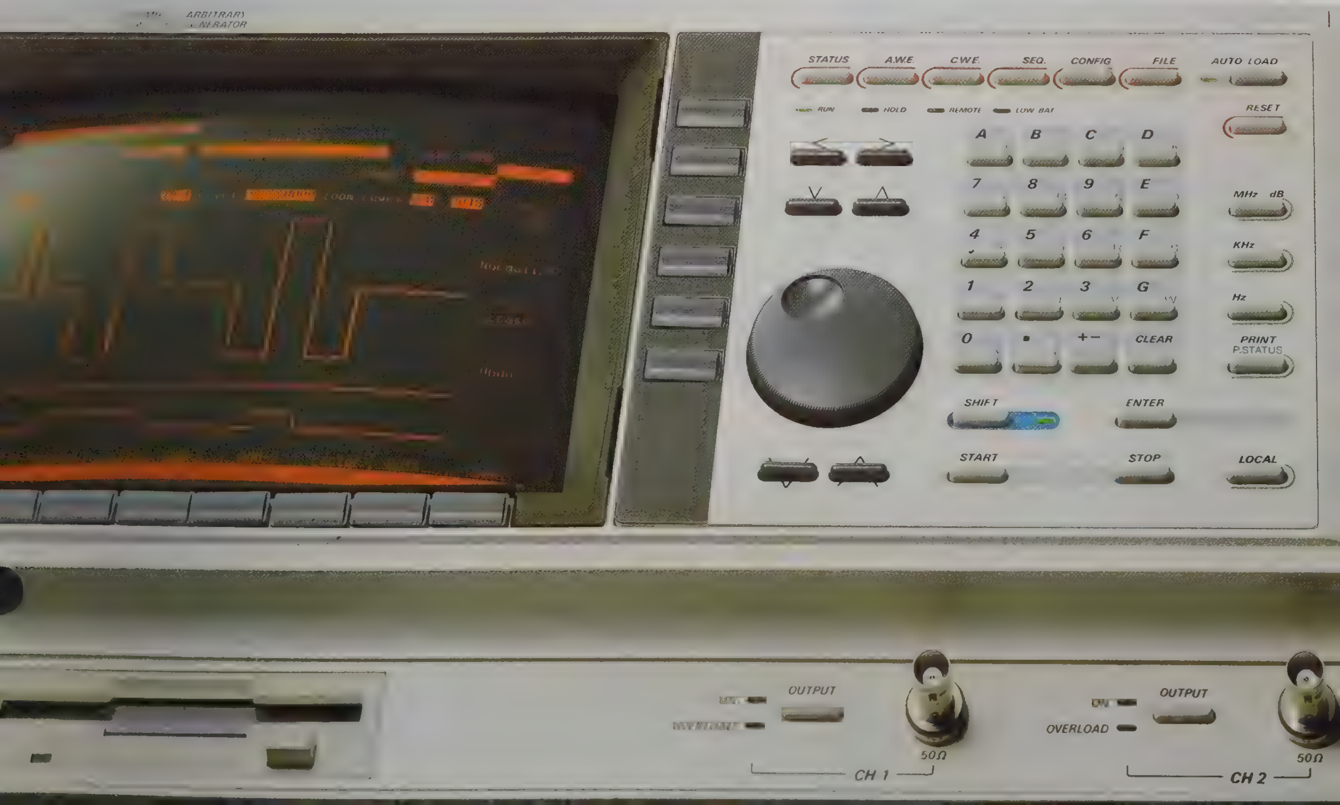


## 2100A **High-Resolution 10 bits, 100MHz Model**



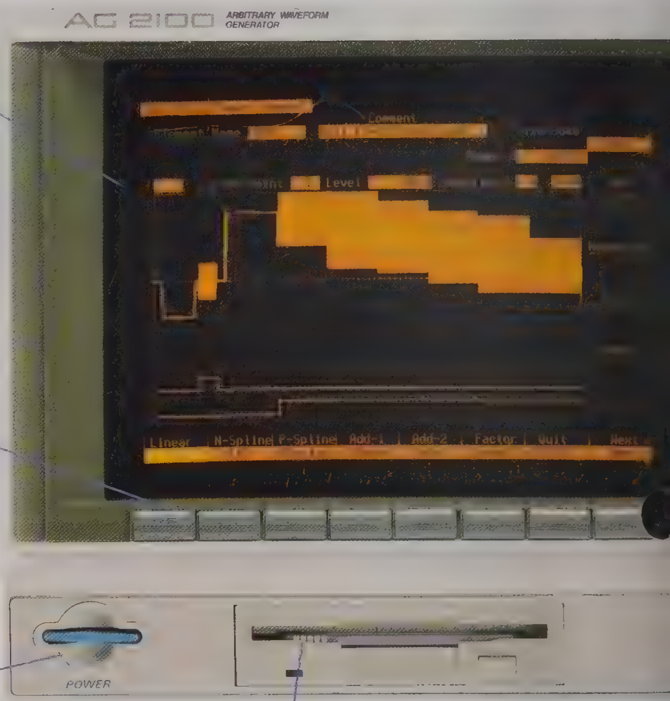
## AG2200 **High-Speed 200MHz, 8 bits Model**





# Well-Designed Man-Machine Interface.

*The AG2000 Series is an all-in-one waveform generator combining waveform creating, monitoring and editing functions in a single CRT-based unit, eliminating the inconvenience of interfacing to personal computers. Well-designed man-machine interface makes the AG2000 Series extremely easy-to-use.*



### 9-inch CRT Display

Large amber CRT and antireflection filter display the parameter settings and waveform with extreme clarity.

### Soft Keys

Function selections are speeded by software defined keys below the corresponding menu labels on the CRT display.

### Power Switch

**Easy storage and recall of waveform.**

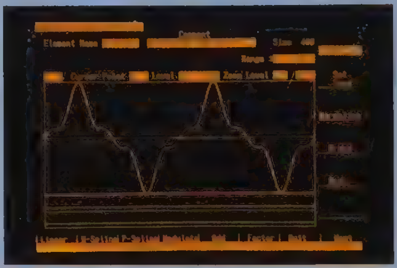
Created waveforms can be labeled and stored on floppy disks to create your own waveform library. A previously created waveform can be recalled at any time.

### 3.5-inch Floppy Disk Drive

Floppy disk drive is built in.*

## Menu-Driven, Simple Operation.

Operations are very simple with the AG2000 Series menu-driven system. You can create waveforms and set various parameters by stepping through the menus displayed at the bottom and right side of the CRT.



The screen can be updated by pressing the function selection key, and then setting the individual parameters with the soft keys. For example, when you want to edit a waveform using Scope Draw, first select the A.W.E. display.
Next, select the Edit mode with the soft keys at the right side of the CRT and display the previously defined waveform on the CRT.

## Cursor Keys

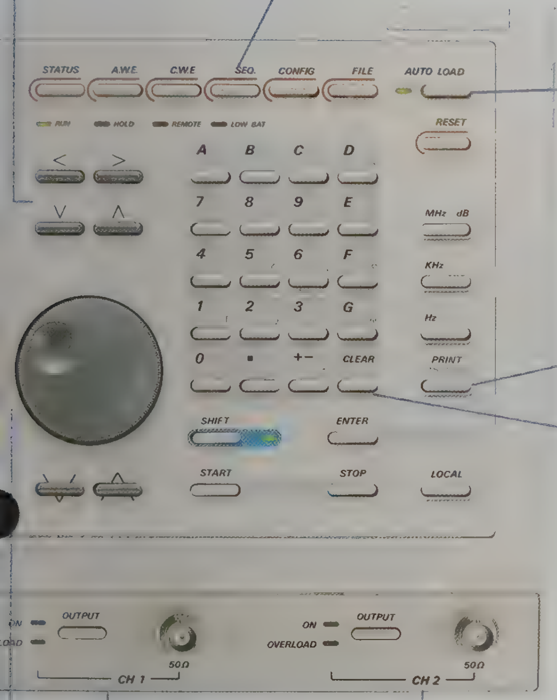
Used for changing the item to be set.

## Function Select Keys

The AG2000 Series provides six types of functions. These are easily selected by pressing the corresponding key.

1. **STATUS:** Output parameter settings
2. **A.W.E.:** Creating and editing waveforms by scope draw
3. **C.W.E.:** Function definition
4. **SEQ:** Sequence programming
5. **CONFIG:** System configuration
6. **FILE:** File operations

Note:
A.W.E. = Arbitrary Wave Element
C.W.E. = Computed Wave Element
SEQ = Sequence Program
CONFIG = Configuration
FILE = File Management



## AUTO LOAD Key

This Auto Load function, lets you load any of up to 16 waveform data sets and 12 sequence programs automatically from the floppy at power-ON or with one touch of a key.

## Printout Key

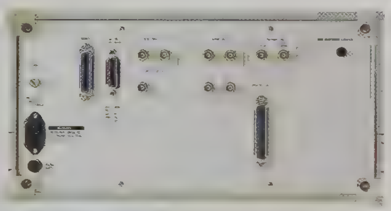
Screen displays or programs can be output to a printer via a Centronics parallel interface.

## Numeric Keypad

Used to enter waveform names, numeric values and parameter settings.

## Output Terminals (CH1, CH2)

Channels 1 and 2 can independently output defined waveforms

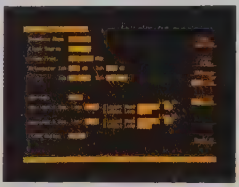


## Rear Panel

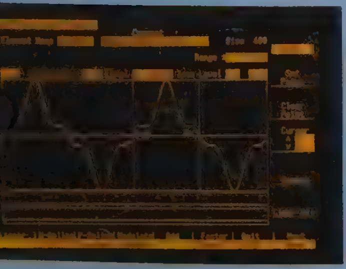
- GPIB/Centronis parallel interface
- Synchronous output of Event (2-bit, ECL) and Sync (2-bit, ECL, TTL)
- Digital data output (optional)
- EXT clock and gate inputs

## Rotary Knob

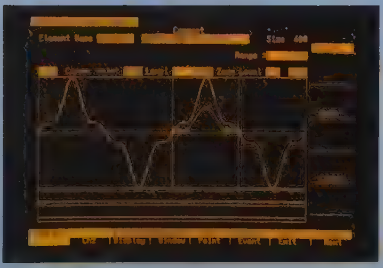
Enables speedy variation of output frequencies and levels, and selection of waveform points for entry or editing.



STATUS display



Then, specify the portion of the waveform to be edited by marking it with the WINDOW key found in the lower corner of the CRT and place dots to change the waveform.



When finished, press the N-Spline key to complete the process.

# Diversified Waveform Creating Functions.

*Pursuing ideal waveform simulation, YOKOGAWA developed an advanced arbitrary waveform generator, the AG2000 Series, which provides a broad range of advanced, easy-to-use waveform creating functions. Using the AG2000 Series, waveforms can be shaped as close to the ideal waveform as you require.*

## Carry Simulation Reliability to Its Limits

■ **AG2100A**

**Maximum clock rate : 100MHz**

**10-bit D-A converter**

■ **AG2200**

**Maximum clock rate : 200MHz**

**8-bit D-A converter**

The AG2000 Series allows generation of high frequency, wide bandwidth waveforms. The AG 2200 (AG2100A specifications in parenthesis) utilizes a 200MHz, 8-bit (100MHz, 10-bit) D-A converter. The clock rate can be set from 1Hz to 200MHz (100MHz) in steps of 1Hz increments. The clock jitter is less than 100ps rms (150ps rms) (phase detection bandwidth: 50Hz to 200 kHz). This stable clock rate, even at a low frequency of 50Hz, allows generation of an entire revolution (ex. 16.6ms) of magnetic disk signal with incredibly low jitter.

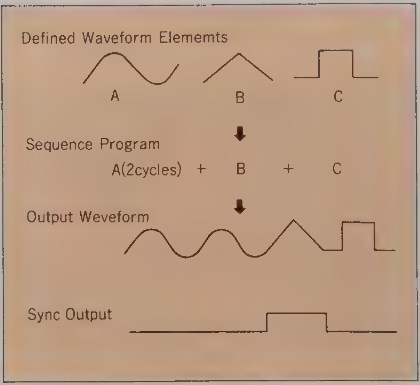
Furthermore, separation of the analog digital sections reduces noise. The output can be attenuated in 0.5dB steps up to 63.5dB to produce any necessary output level. For applications requiring greater than 1 Vp-p output, YOKOGAWA has produced a seperately sold 50MHz amplifier. The output filter can be set to 100M (AG2200 only), 50M, 20M, 10M, 5M, 2MHz, or OFF.

### Sequence Programming with 128KW of Waveform Memory

128K words of memory is available for generating arbitrary waveforms, up to 16 waveforms can be created with lengths set from 64 words to 8K words (in 16 words steps) for the AG2200, or from 32 words to 8K words (in 8 word steps) for the AG2100A.

These waveform elements can be joined together and looped with Sequence Programming. The looping can be set from 1 to 65,535 or for infinite looping. There are also two Sync outputs, synchronized to the analog output. These can be set for ECL and TTL level output.

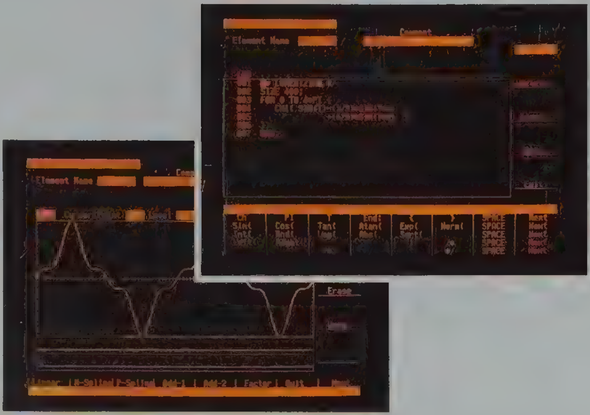
The figure below shows how three different waveform elements can be conbined to define one cycle of an output waveform.

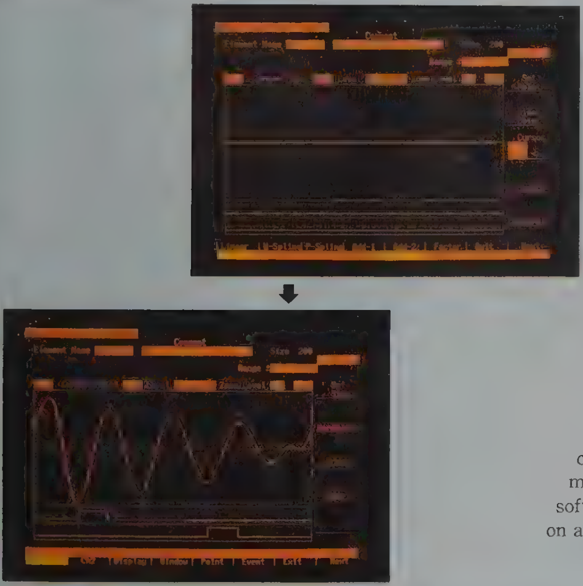


## Mathematical Formulas

A major feature of the AG2000 Series is the variety of methods for creating waveforms. The easiest method is the using of function definition.

Even highly complex waveforms can be easily generated if they can be defined in the form y=f(t). The AG2000 Series has functions for SIN, COS, TAN, TAN$^{-1}$, EXP, LOG, Absolute Value, and Square Root, as well as features such as noise function and phase shift. These functions can be selected and set by using the soft keys, making waveform definition easy and accurate. For example, the trigonometry functions SIN and COS can be used to easily express a waveform made up of fundamental and harmonics. Also, the EXP function makes it easy to generate rising and falling pulse edges or damped waves.





## Scope Draw

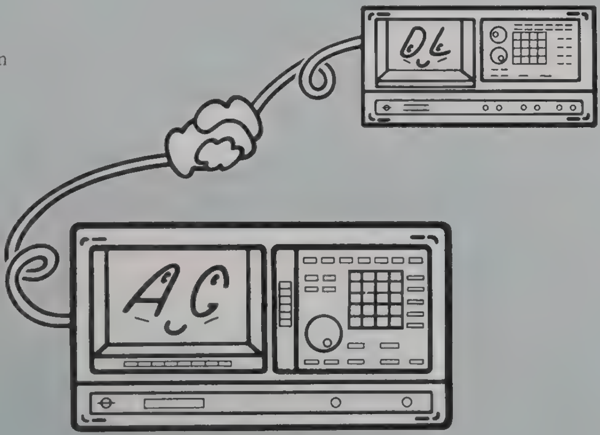
The AG2000 Series lets you use the screen like a canvas to draw any waveform you want. The rotary knob is used to make a rough sketch with dots, and then the sketch is turned into a smooth waveform by spline interpolation. Scope Draw can also be used to edit a portion of the created waveform, not only those created with Scope Draw, but also those created by function definition, and even actual waveforms downloaded from an oscilloscope. Editing is done by selecting a particular part of the waveform, magnifying it, and then modifying the magnified section. Thus, even minute alterations can be made quickly and accurately.

Furthermore, you can set two Event outputs synchronize with the analog output. These signals can be set to go low or high at any point in the analog signal cycle, and can be used as trigger or synchronization signals for other measurement instruments. With optional data conversion software, waveform creation and editing can also be done on a personal computer.

## Actual Waveforms

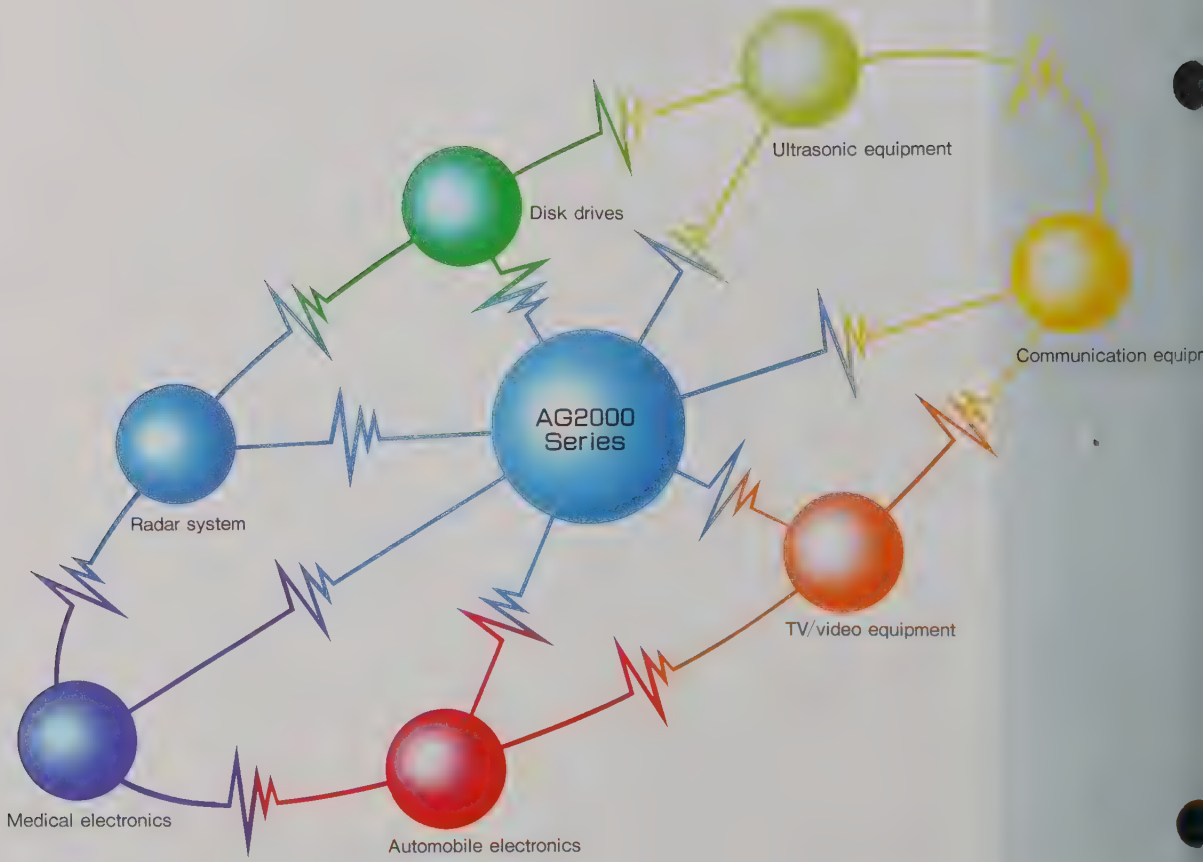
The ability to use "real" signals is very convenient in cases of very complex, hard-to-define waveforms or to reproduce real-world phenomena in the lab. The AG2000 Series features the ability to download waveforms captured by a digital oscilloscope directly, without the need to use a PC interface or write tedious GPIB programs. Complex signals such as hard disk data, breaker operation waveform or radar transmission/reception pulses can be loaded into the AG2000 Series and reproduced again and again. Of course, these signals can be freely modified using Scope Draw.

When down-loading from oscilloscopes other than the YOKOGAWA DL Series, a DATA TRANSFER UTILITY sold separately is necessary.



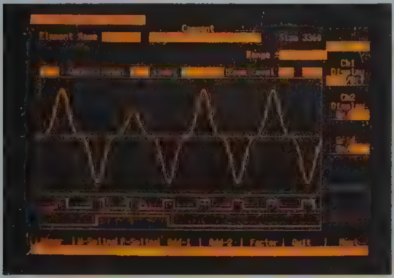
# Waveform Generating Simulations.

*The AG2000's waveforms are best suited for various fields of product evaluation tests with great efficiency of product development.*



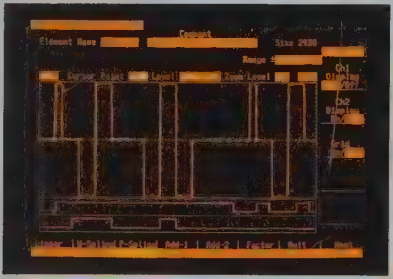
## Disk Drives

With the increases in disk densities and speeds, a variety of signals are necessary for disk drive demodulation circuit evaluation tests. In the past, these tests were done using reference disks. However, there were still problems with repeatability, maintainability, and durability. Further, it was impossible to deal with problems such as peak shifts, missing bits, and extra bits. However, using the AG2000 Series, more efficient tests can be performed, allowing the development of higher quality products. Any kind of NRZI, FM, or MFM signal can be easily created with the AG2000 Series by constructing a single waveform of the disk read signal and setting up a bit pattern. Then, Scope Draw can be used to introduce peak shifts and other signal aberrations into the output, making for easier and more efficient development of high-quality products.


Element Name
Comment
Size 3360
Range
Ch1
Display
Ch2
Linear | B-Spline | P-Spline | Add-1 | Add-2 | Factor | Quit | Next

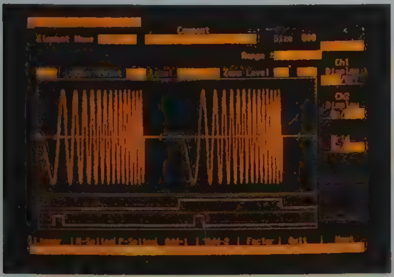
## Communications Equipment

As we head into the advanced information age, the pace of progress in digital communication technology grows ever more intense. There is a pressing demand for signal generators which can cope with this advanced technology. The AG2000 Series can handle not only modulation signals required for conventional analog communications such as AM, FM, and PM waveforms, but also simulation of transmission waveforms for sophisticated information systems such as the Integrated Services Digital Network (ISDN). The diverse waveform creating functions of the AG2000 Series make it easy to simulate distorted transmission signals and control arbitration signals which are especially problems in ISDN development.



## Radar Systems

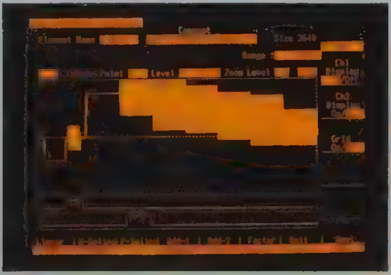
In radar system product development, it is indispensable to perform tests with waveforms closely approximating the actual. The pulse signals used in radar transmission signals are far from ideal, and usually contain overshoot and ringing. Complex waveforms such as chirp signals are becoming widely used. In past tests, these signals were created by using pulse or function generators for pulse signals and special hardware for chirp signals. However, since this did not permit accurate creation of the required waveforms, it was impossible to get accurate results. Using the AG2000 Series chirp signals can be easily defined with mathematical formulas, noise can be added, or a part of the waveform can be edited. Thus, more realistic tests can be performed.



## TV/Video Equipment

With the arrival of the new media age, television, video, and audio equipment is becoming increasingly diverse and advanced, and the competition is strong for enhancements in quality. In television, rapid progress is being made in picture quality improvement through new technologies such as larger screens, high resolution, and ghost cancellation with EDTV. Conventional video generators can no longer handle testing of such advanced technology. However, with the AG2000 Series, phases and amplitudes can be freely varied, so it is simple to generate nonstandard video signals and signals required for digital processing.

Moreover, since a signal can be stored on a floppy disk and a library created, any kind of test can be replicated at any time.

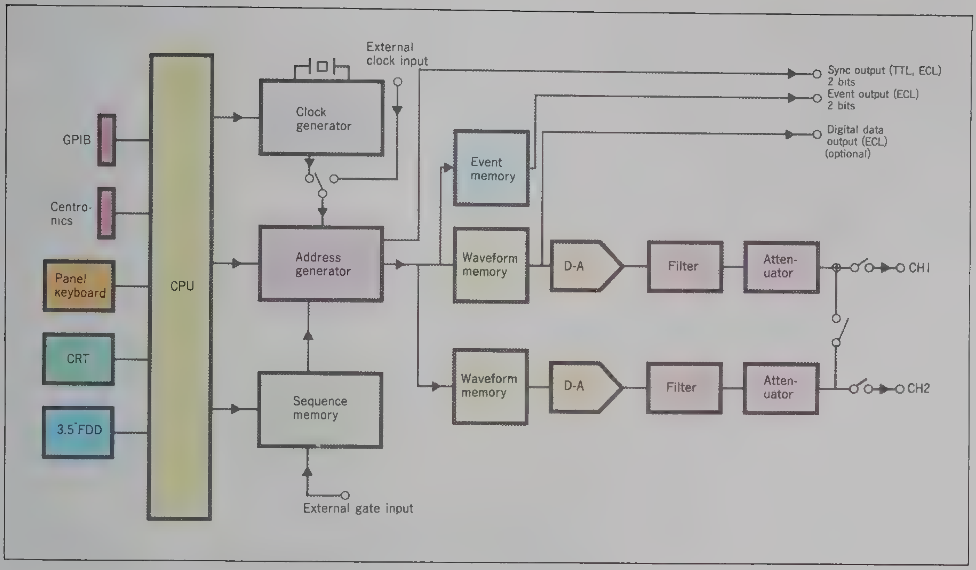


# Specifications

<table>
<tr><th colspan="2">MODEL</th><th>AG2100A</th><th>AG2200</th></tr>
<tr><td rowspan="14">Output</td><td>Output channels</td><td>One (705011), or two (705012)</td><td>One (705021), or two (705022)</td></tr>
<tr><td>DC accuracy</td><td>< ±(0.5% of setting + 20 mV) (attenuator at 0 dB)</td><td>< ±(1% of setting + 40 mV) (attenuator at 0 dB)</td></tr>
<tr><td>DC stability</td><td>< ±(500 ppm of setting + 2 mV)/°C</td><td>< ±(500 ppm of setting + 2 mV)/°C</td></tr>
<tr><td>Output impedance</td><td colspan="2">50Ω (nominal)</td></tr>
<tr><td>Maximum output voltage</td><td colspan="2">2 Vp-p (50Ω load, attenuator at 0 dB), 4 Vp-p (CH1 + CH2 summing mode, 50Ω load, attenuator 0 dB)</td></tr>
<tr><td>Output resolution</td><td>10 bits</td><td>8 bits</td></tr>
<tr><td>Rise time</td><td><10 ns (10 to 90%, with filter OFF)</td><td><5ns (10 to 90%, with filter OFF)</td></tr>
<tr><td>Output noise (reference value)</td><td>−55 dBm (non-clock components), −45 dBm (clock component) (Conditions: DC output, clock 100 MHz, attenuator 0 dB, filter 50 MHz)</td><td>−55 dBm (non-clock components), −45 dBm (clock component) (Conditions: DC output, clock 200 MHz, attenuator 0 dB, filter 100 MHz)</td></tr>
<tr><td>Attenuator</td><td colspan="2">0 dB to 63.5 dB. (0.5 dB steps)</td></tr>
<tr><td>Filter</td><td>2 MHz, 5 MHz, 10 MHz, 20 MHz or 50 MHz selectable (overshoot ± 5% maximum, except when fillter OFF and in CH1 + CH2 summing mode)</td><td>2 MHz, 5 MHz, 10 MHz, 20 MHz, 50 MHz or 100 MHz selectable (overshoot ± 5% maximum, except when filter OFF and in CH1 + CH2 summing mode)</td></tr>
<tr><td>Interchannel skew</td><td>< ±5 ns (filter OFF)</td><td>< ±2.5 ns (filter OFF)</td></tr>
<tr><td>Interchannel crosstalk (reference)</td><td>−50 dB (filter 50 MHz)</td><td>−50 dB (filter 100 MHz)</td></tr>
<tr><td colspan="3"></td></tr>
<tr><td colspan="3"></td></tr>
<tr><td rowspan="5">Internal clock</td><td>Clock rate</td><td>1 Hz to 100 MHz</td><td>1 Hz to 200 MHz</td></tr>
<tr><td>Resolution</td><td colspan="2">1 Hz</td></tr>
<tr><td>Accuracy</td><td colspan="2">< ±3 ppm</td></tr>
<tr><td>Stability</td><td colspan="2">< ±6 ppm/5 to 40°C, < ±3 ppm/year</td></tr>
<tr><td>Jitter</td><td><150 ps rms (phase detection bandwidth: 50 Hz to 200 kHz)</td><td><100 ps rms (phase detection bandwidth: 50 Hz to 200 kHz)</td></tr>
<tr><td rowspan="3">Internal memory</td><td>Waveform memory</td><td>128K words/channel (10 bits/word), up to 16 waveform types of up to 8K words per waveform settable</td><td>128K words/channel (8 bits/word), up to 16 waveform types of up to 8K words per waveform settable</td></tr>
<tr><td>Event memory</td><td colspan="2">128K words (2 bits/word), two event bits per waveform can be set for each word in waveform memory</td></tr>
<tr><td>Sequence memory</td><td colspan="2">682 steps/sequence: program can be set up to 682 steps per sequence.</td></tr>
<tr><td rowspan="6">Auxiliary I/O</td><td>External clock input</td><td>100 kHz to 100 MHz/0 to 10 dBm (AC coupling, input impedance 50Ω)</td><td>100 kHz to 200 MHz/0 to 10 dBm (AC coupling, input impedance 50Ω)</td></tr>
<tr><td>External gate input</td><td colspan="2">TTL/ECL level selection (input impedance 10 kΩ)</td></tr>
<tr><td>Event output</td><td colspan="2">2 bits (ECL level, 50Ω serial termination)</td></tr>
<tr><td>Sync output</td><td colspan="2">2 bits (TTL and ECL level, 50Ω serial termination)</td></tr>
<tr><td>Digital output (optional)</td><td>10 bits (ECL level), offset binary code, CH1 data only</td><td>8 bits (ECL level), offset binary code, CH1 data only</td></tr>
<tr><td>Clock output</td><td>Pulse width: approx. 4 ns (ECL level, 50Ω serial termination)</td><td>Duty: approx. 50% (ECL level, 50Ω serial termination)</td></tr>
<tr><td rowspan="2">Interface</td><td>GPIB</td><td colspan="2">Conform to the IEEE St'd 488-1978 (JIS C1901-1987)<br>Interface codes: SH1, AH1, T6, L3, SR1, RL1, PP0, DC1, DT1, C1, C2, C3, C4, C27</td></tr>
<tr><td>Printer output</td><td colspan="2">Connector: Centronics<br>Control Sequence: NEC PR series, Epson ESC/P-J81, J82, J83 conformance</td></tr>
<tr><td rowspan="8">General</td><td>Display</td><td colspan="2">9-inch CRT (amber)</td></tr>
<tr><td>Floppy disk</td><td colspan="2">3.5-inch 2HD</td></tr>
<tr><td>Operating temperature range</td><td colspan="2">5 to 40°C (41 to 104°F)</td></tr>
<tr><td>Operating humidity range</td><td colspan="2">20 to 80% RH (max. wet bulb temperature 29°C)</td></tr>
<tr><td>Power requirements</td><td colspan="2">90 to 132V AC or 180 to 250 V AC, 48 to 63 Hz</td></tr>
<tr><td>Power consumption</td><td colspan="2">500VA max.</td></tr>
<tr><td>Weight</td><td>Approx. 24 kg (705011), approx. 25 kg (705012)</td><td>Approx. 24 kg (705021), 25 kg (705022)</td></tr>
<tr><td>External dimensions</td><td colspan="2">Approx. 221(H)×426(W)×619.4(D)mm, (8-11/16×16 3/4×24-3/8")</td></tr>
</table>

Reference operating conditions···Ambient temperature 23±2°C, humidity 50±10% R.H., Warming up time 30 min. or more.

## ■Block Diagram



## ■Model and suffix codes

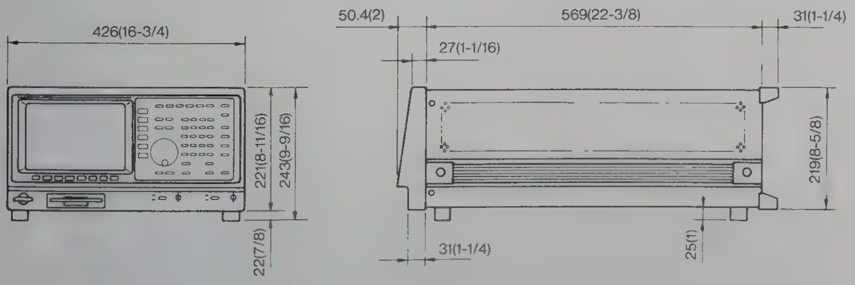
| Model | Suffix code | Description |
|---|---|---|
| 7050 | | AG2000 Series |
| Function | 31 | AG2100A, 1 channel |
| | 32 | AG2100A, 2 channels |
| | 21 | AG2200, 1 channel |
| | 22 | AG2200, 2 channels |
| Power requirements | -1 | 90 to 132 V AC |
| | -5 | 180 to 250 V AC |
| Optional features | /2DD | IBM Format, 2DD(720K bytes) |
| | /2HC | IBM Format, 2HC(1.2M bytes) |
| | /DOUT | Digital output |

## ■Optional accessories

| Name | Part No. | Specifications | Order Q'ty |
|---|---|---|---|
| BNC cable | 366924 | BNC-BNC (1m) | 1 unit |
| BNC cable | 366925 | BNC-BNC (2m) | 1 unit |
| Interface cable | B9801KA | Connection cable to printer | 1 unit |
| Cleaning kit | 700921 | For CRT (1 set/unit) | 1 unit |
| Cart | 700991 | For AG, DL series | 1 unit |

## ■DIMENSIONS

Unit: mm (inch)



# AG 2100A
# AG 2200
## ARBITRARY WAVEFORM GENERATOR

YOKOGAWA

**YOKOGAWA ELECTRIC CORPORATION**
*TOKYO SALES OFFICE:* Shinjuku Center Bldg. (48F),
P.O. Box 4125, 1-25-1 Nishi Shinjuku, Shinjuku-ku, Tokyo 163, JAPAN
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**YOKOGAWA CORPORATION OF AMERICA**
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Subject to change without notice.

Represented by:

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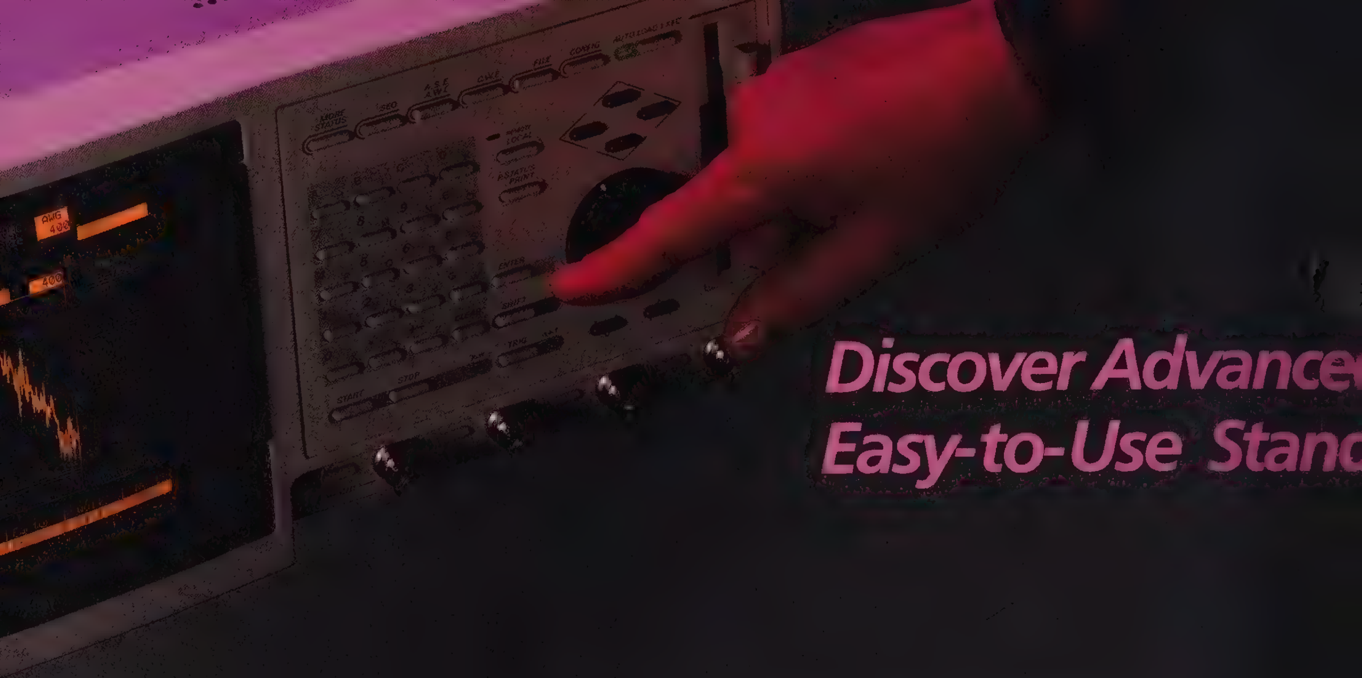
# AG1200 • Arbitrary Waveform Generator

YOKOGAWA ◆

Bulletin 70[illegible]

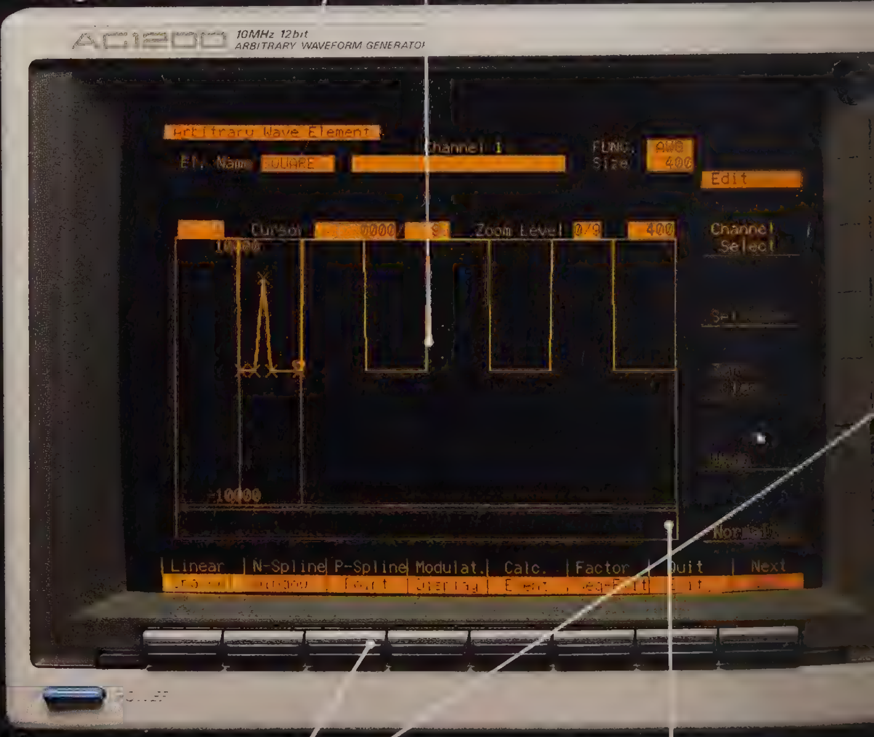


# *Discover Advance Easy-to-Use Stan*

*The AG1200 Arbitrary Waveform Generator puts a wide range of advanced capabilities at your fingertips. It's simple to use, yet offers features unavailable from other arbitrary waveform generators or function generators even with a personal computer. You gain flexibility and features that cut development time and enhance product quality. Quite simply, the advanced AG1200 meets the sophisticated development and testing needs for today's products.*

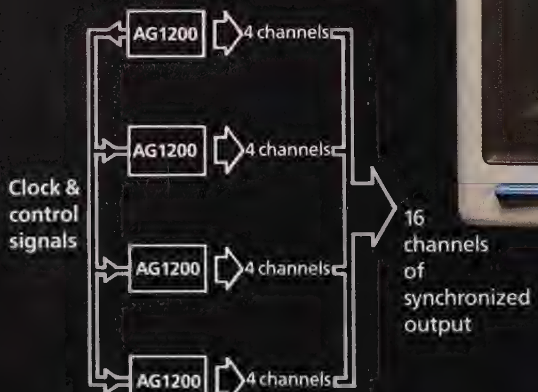
**12 BIT VERTICAL RESOLUTION:**
Meets demanding requirements for accuracy and wide dynamic range.

**"SCOPE DRAW" MODE:**
Makes it easy to create your unique waveforms and waveform components.



**CRT MENU BUTTONS:**
Provides easy waveform creation and output mode control.

**9 INCH CRT:**
Lets you view waveforms and waveform programs as you create them, without a PC or other display device.

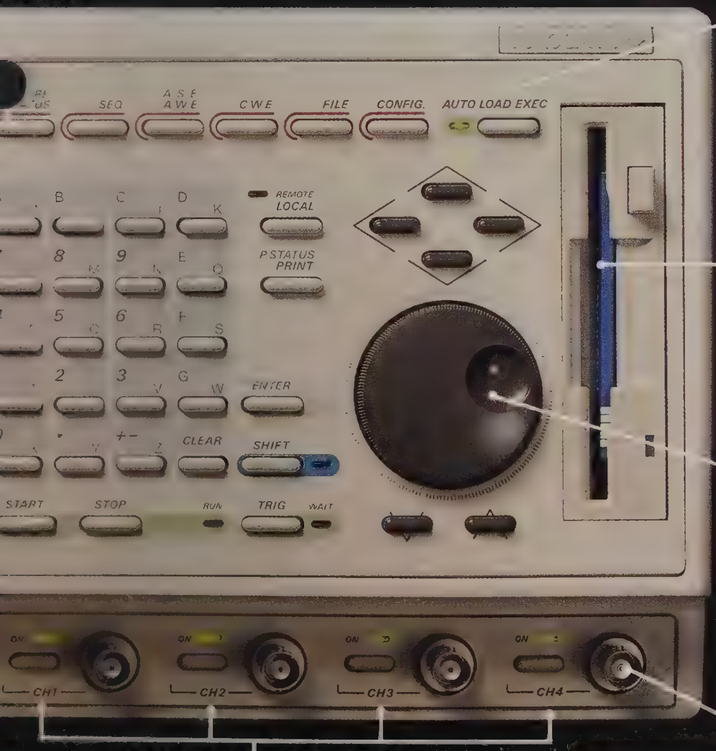


### Select from four AG1200 models

| AG1200 Model Number | 705110 | 705120 | 705140 | 705142 |
|---|---|---|---|---|
| No. of Analog Channels | 1 | 2 | 4 | 4 |
| Digital Pattern Output | No | No | No | Yes, channels 3 and 4 |
| Maximum Clock Rate | 10 MHz | 10 MHz | 10 MHz | 10 MHz |
| Vertical Resolution | 12 bits | 12 bits | 12 bits | 12 bits |
| Waveform Memory | 32,000 W/CH | 32,000 W/CH | 32,000 W/CH | 32,000 W/CH |
| Maximum Output Voltage | +/- 10V | +/- 10V | +/- 10V | +/- 10V |
| Mass Storage | Yes, Floppy Disk | Yes, Floppy Disk | Yes, Floppy Disk | Yes, Floppy Disk |
| Direct Hardcopy Output | Yes | Yes | Yes | Yes |

## ontrol in one lone Design

**SELECTABLE FUNCTIONS:** Provides 3 types of waveform generation: Arbitrary Waveforms, Digital Pattern Generator, and Function Generator modes, making the AG1200 a complete solution to your signal generation needs.



**AUTO LOAD:** Provides immediate access to the waveforms you specify, reducing setup time, and eliminating operator errors.

**3.5 INCH FLOPPY DISK DRIVE:** Provides permanent mass storage of waveform files.

**ROTARY KNOB:** Allows real time adjustments to waveform output frequency, amplitude delay and other functions.

**FOUR FULL CHANNELS:** Masters complex systems applications that require multiple signals for both analog and digital stimuli.

**32,000 WORD/ CHANNEL MEMORY:** Provides for single-shot long period events or repetitive long time duration waveforms.

# Creating Waveforms Becomes as Easy as 1, 2, 3

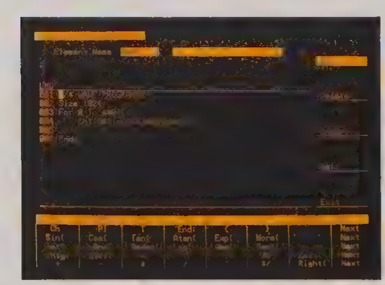
*The AG1200 Arbitrary Waveform Generator is designed to provide you with the maximum flexibility achievable in signal generation. With operating simplicity and abundant capabilities, the AG1200 answers more of your signal g tion needs. Use any of three modes of operation includ Arbitrary Waveform Generator, Pulse/Digital Pattern Generator, or Function Generator to meet your test, evaluation, or simulation signal generation needs.*

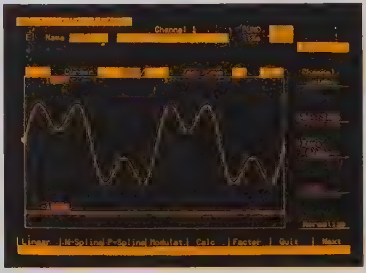
## DESCRIBE

*The AG1200 Arbitrary Waveform Generator is designed as a stand-alone unit. You can create waveform components, view results, and modify your work without additional equipment.*

*Waveform programs are quickly and easily generated, edited, or modified from the front panel symbol-driven program generator. Program generator functions include: SIN, COS, TAN, EXP, LOG, ABS, SQRT, random noise and others. Waveform components that have been described in a program can be viewed on-screen to verify results immediately, reducing errors and questions.*

*Once you have created a waveform, you will never need to repeat the process again. Your waveform programs can be saved to a floppy disk via the AG1200's built-in floppy disk drive. The next time you need it, simply call up the waveform file and output the signal. This allows you to quickly and easily generate the waveforms you need. The result: increased effectiveness and efficiency in solving your toughest problems.*




Channel 1
Linear | N-Spline | P-Spline | Modulat | Calc | Factor | Quit | Next

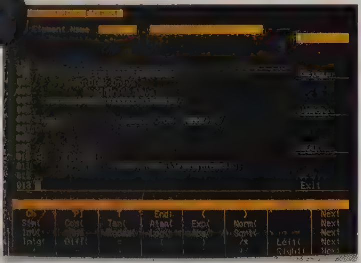
## DRAW

*The AG1200's "scope draw" mode allows you to modify existing waveforms or create new waveforms from scratch by simply drawing them. Mark the desired horizontal and vertical points and push a button; the waveform element is created, using one of 3 internal waveform interpolators.*

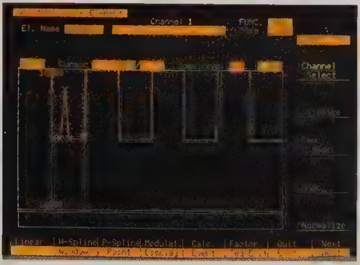
*Create signals that simulate worst case conditions such as power supply failure,*

You can create waveforms using any of three methods:

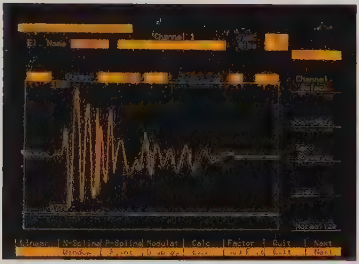
1) Describe your waveform using arithmetic expressions



2) Use the "scope draw" mode to create your waveforms



3) Download your waveforms directly from a Yokogawa Digital Oscilloscope.



power surges, glitches, power drops, or other abnormal events. Test for failure modes, operating limits, or worst case scenarios on a device under test. And, cause the AG1200 is designed with lexibility in mind, it is fully programmable, portable, and a perfect solution for testing on your bench, in your system, or in the field.

## 3

## DOWNLOAD

Testing can be expensive and time consuming! Often testing requires traveling to a remote location or the destruction of the device under test; you have only a single opportunity to capture all the data of interest. You modify your design, but does it solve the problem? You need to reproduce the test conditions.

Now, you need only run your test once. Capture your test signals with a Yokogawa DL Series Digital Oscilloscope, and download them directly to the AG1200, without a controller or PC.* Once you have the waveforms in the AG1200, you can reproduce them whenever you need. You can recreate your waveforms as captured, or modify them, using "scope draw," then simulate real world signal conditions in your lab. The AG1200 offers the perfect solution to destructive test and non-destructive test simulation, power distortion testing, mechanical, and electro-mechanical test simulations.

The AG1200 represents an opportunity to reduce testing time and costs significantly. Simulate your field test signals over and over in your lab, resulting in reduced design, development and testing cycles.

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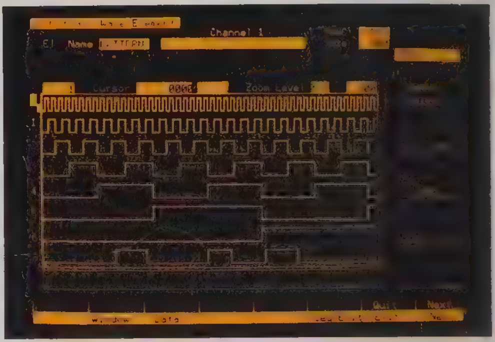
*Yokogawa also offers a utility software package for downloading waveforms from other manufacturers' oscilloscopes to the AG1200.

# TESTING Solves Critical Problems

## AUTOMOTIVE

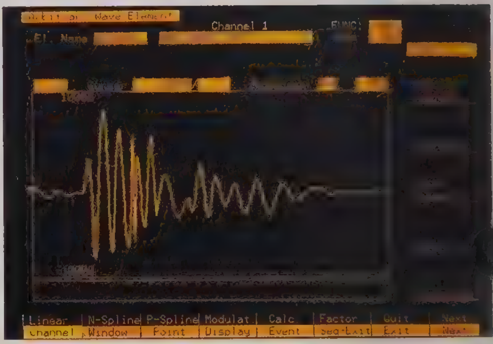
*Sensitive electronic devices that control vital operations in the hostile environment of an automobile make reliability and reliability testing increasingly complex. Now, with the AG1200's analog and digital signal output capabilities, you can easily test mixed technology devices, such as embedded microprocessor engine control units.*



## VIBRATION

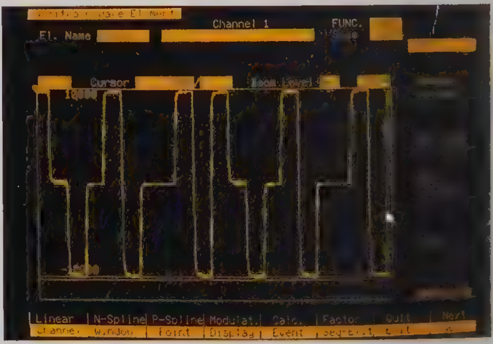
*Field testing of your new hull design is complete. You need to make some slight modifications and retest. But time and costs are critical, and another trip to the test site means cost overruns and project delays.*

*Now, with the AG1200, you can recreate vibration waveforms captured on-site. Then conduct destructive and non-destructive tests in your laboratory, reducing testing cost and design cycle times significantly.*



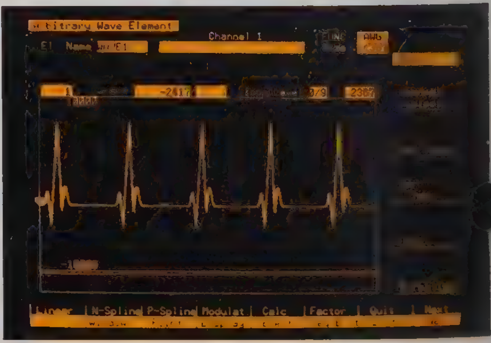
## MOTOR DRIVE

*The AG1200's 4 analog channels can provide 4-phase pulse signals for pulse motor drives, ultrasonic motors, and other devices.*



## MEDICAL EQUIPMENT

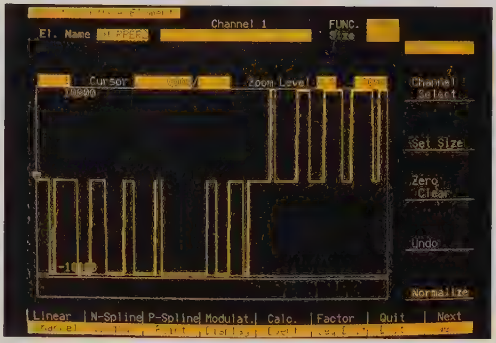
*Medical monitoring equipment provides the physician with critical information about a patient's condition. The AG1200's 12 bit vertical resolution and high accuracy levels make it ideal for testing equipment where performance and reliability are a primary concern.*



# *EVALUATION Meets Real Needs*

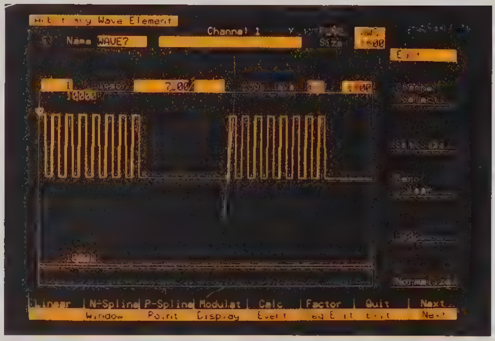
## INVERTER UNIT

*Because public safety depends on the reliability of inverters found in electric rail cars, elevators, and circuit breakers, product testing is critical. With the AG1200's flexible waveform generation capabilities, it can simulate worst case signal conditions, ensuring that device evaluation mirrors real life conditions. The result is a safer, better product!*



## INFRARED REMOTE-CONTROL NOISE EVALUATION

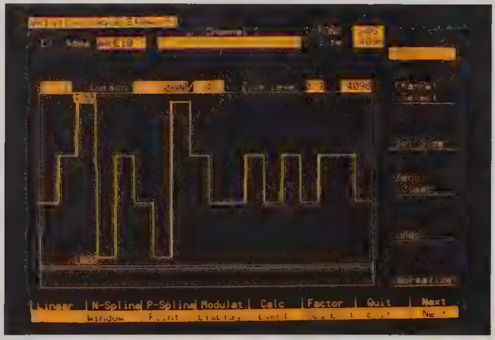
*Evaluate circuit signal to noise performance of an infrared light receiver. The AG1200 can add random noise to your signals and output the result directly into your circuit.*

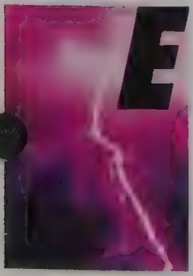


# *SIMULATIONS Become Proven Fact*

## LIQUID CRYSTAL MATERIALS

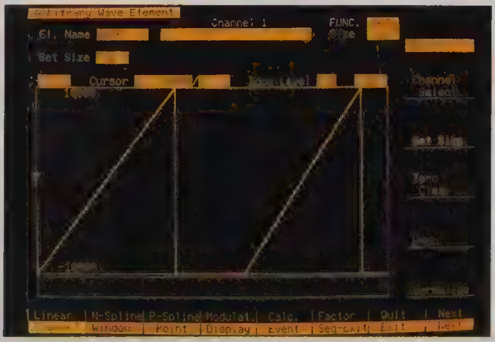
*Simulation of liquid crystal optical characteristics is just one application where the AG1200 can help reduce materials development time and improve overall performance.*



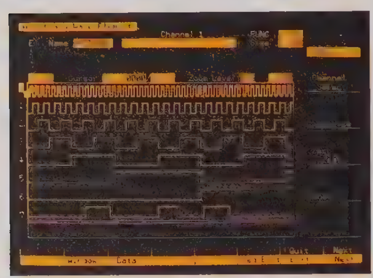


## ELECTRON BEAM APPARATUS

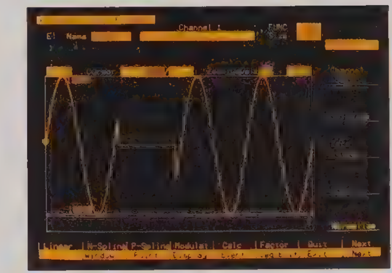
*Your new deflection plate design needs testing, but the drive circuitry is still several weeks away. The AG1200 can simulate device drive signals for deflection plate design, electron beam welding, and electron microscope device development.*



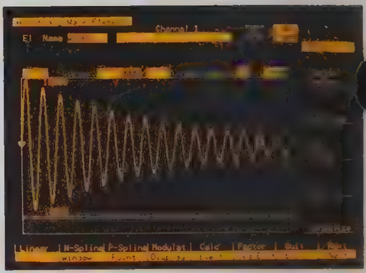
# Flexible Waveform Generation Functions



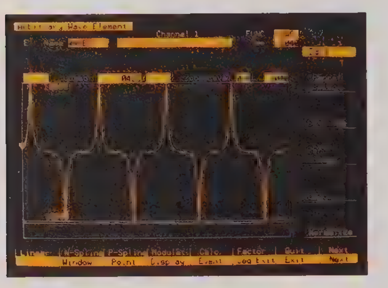
Digital Pattern



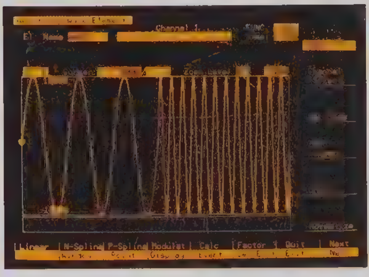
Power Supply Failure



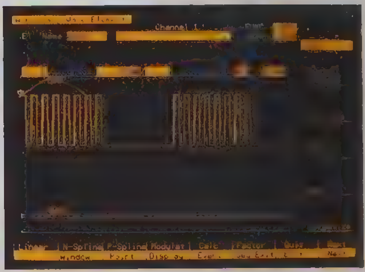
Damped Sine Wave



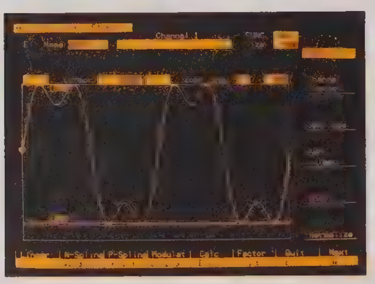
Electromagnetic Pick-up



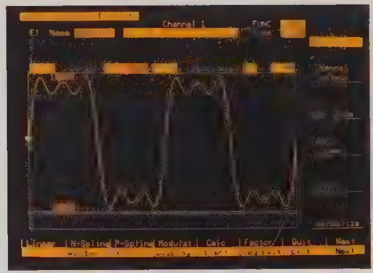
PLL Response



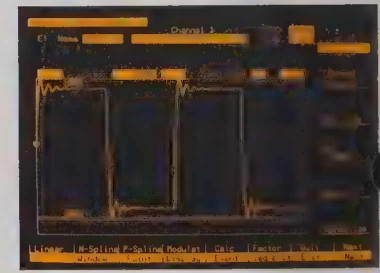
Infrared Control



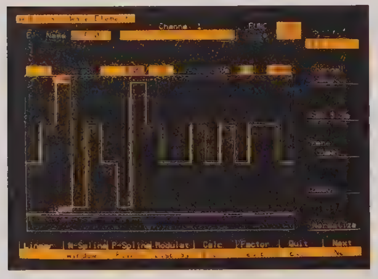
Distorted Sine (3rd Harmonics)



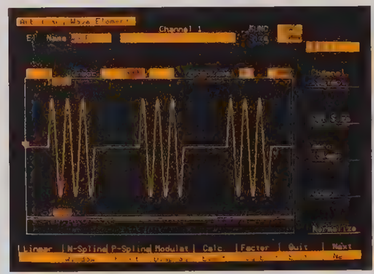
3rd and 5th Harmonics



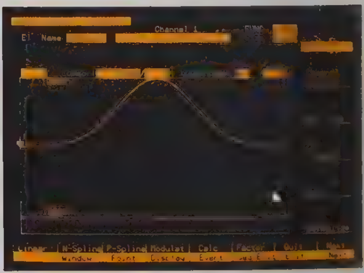
Square wave with overshoot



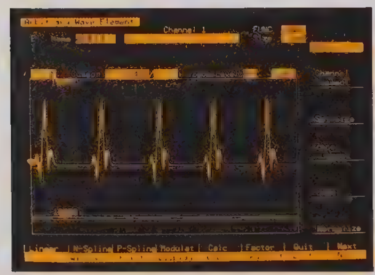
LCD Drive



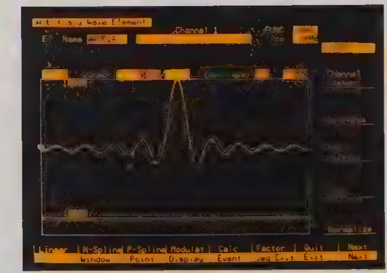
Tone Burst



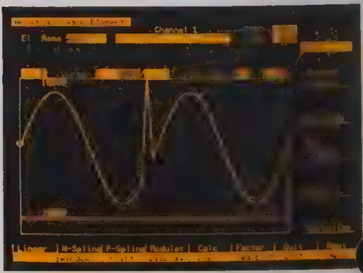
Gaussian Pulse



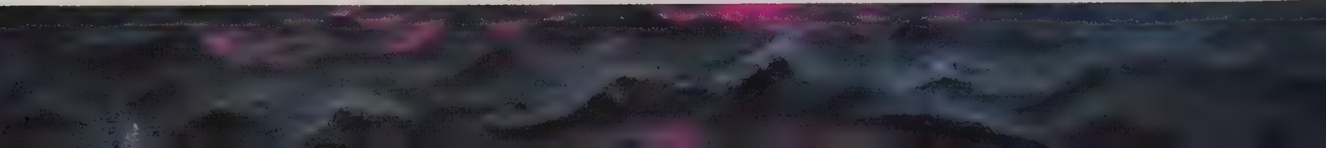
Biomedical Pulse



$\frac{Sin\ X}{X}$



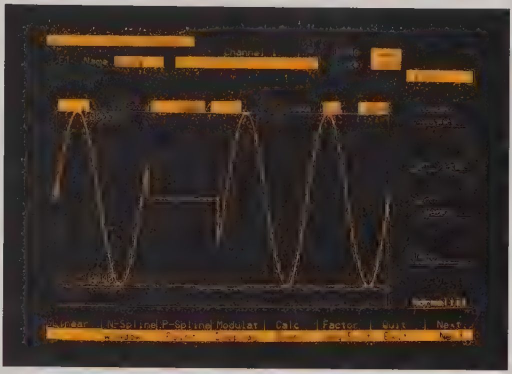
Power Surge



# Generate Independent Functions on Every Channel

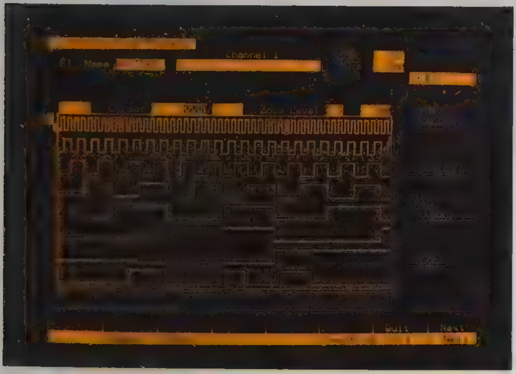
A complete solution to your signal generating needs, the AG1200 can also operate as a function generator on each channel. You can generate sine waves of 2 MHz, as well as triangle, square, and ramp waveforms of 200 kHz, all with independent frequency control for each channel.

The AG1200's flexibility allows you to create complex signal combinations that address a broad range of analog, digital, and mixed technology applications. Create your own waveforms and save them to a disk, or use the library of waveforms that comes with every AG1200 to generate waveforms that help solve your toughest device stimulus problems.

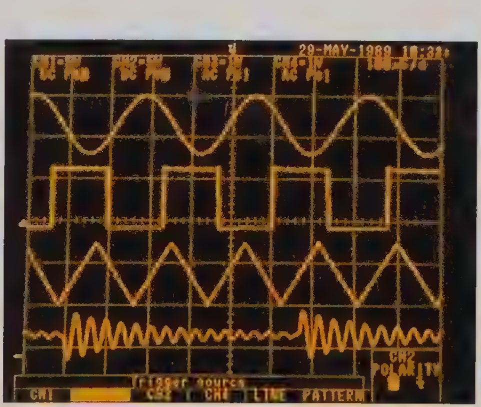

Channel 1
Normalize
Linear | N-Spline | P-Spline | Modulat | Calc | Factor | Quit | Next

The AG1200's flexibility allows you to test device performance under normal signal conditions using the function generator signals. Failure modes can be tested using the arbitrary waveform generation function.
Above: The AG1200 simulates a power failure.

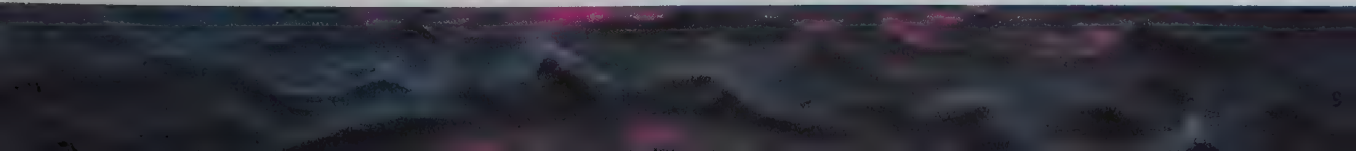
# Simulate and Test Embedded-Microprocessor Systems



Now, the AG1200, Model 705142 provides a solution. Its ability to output two, 16 bit digital patterns in combination with arbitrary waveforms or function generator signals provides a unique single instrument solution for mixed technology simulation and testing.

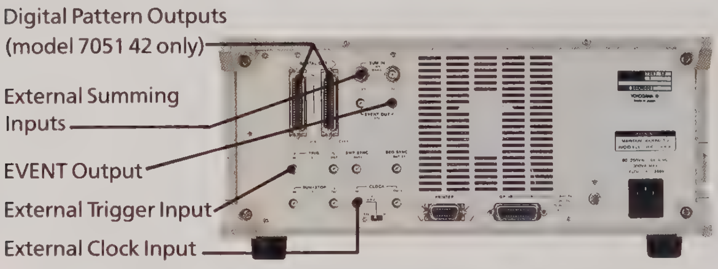


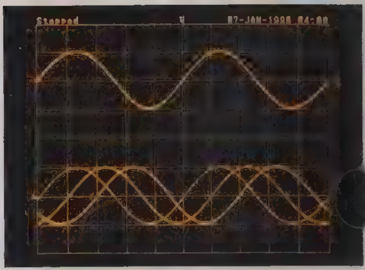
Microprocessor technology appears in almost everything from dishwashers to state of the art aircraft. With this increased use of microprocessor control units comes a requirement to simulate the interaction between electronic and electromechanical devices.



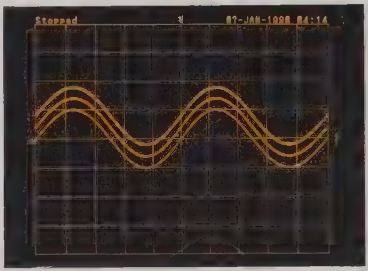
# *Advanced Technology Throughout Including Simultaneous 4-Channel Output*

## Rear Panel Connections





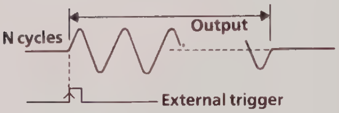
*The AG1200 allows you to adjust phase (delay) between channels independently, as the signals are applied to your device under test.*

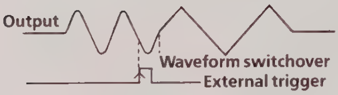


*You can make amplitude and offset changes to each channel independently, as the signals are applied to your circuit.*

# *Triggered and Burst Operations*

## Generate Complex Time/Event Signals





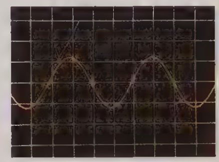
*The AG1200 is designed to meet your most demanding application needs With triggered, burst, and switching operations, waveform outputs can be switched and varied to generate time and event coincident signals that loop, pause for a specified period, or change. You can also inject single shot events automatically or manually.*

# *External Summing Mode*

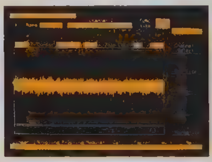
## Add Random Noise to Your Signal

*How sensitive is your circuit to noise? Let the AG1200's External Summing Mode help you determine exactly how much noise your circuit can tolerate. Simply input your signal to the external summing input. Use the summing mode, and return your original signal, with the noise components you have defined, back into your circuit.*

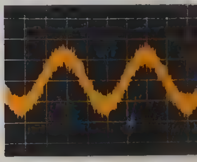
*With the AG1200, you can quickly and easily measure noise tolerances, make circuit changes, and test the results, reducing design and reliability testing time.*



*Your circuit's waveform*



*Random noise generated by AG1200*



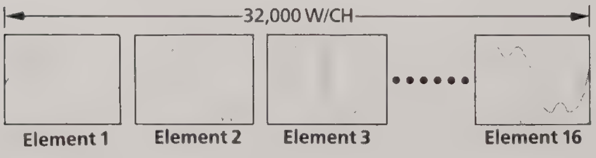
*Summed result ready to be injected into your circuit*

# *Flexibility Meets Your Most Demanding Requirements:*

***Sequence Programs make the most of a large 32,000/channel memory***

*1. Waveform Element Construction:*

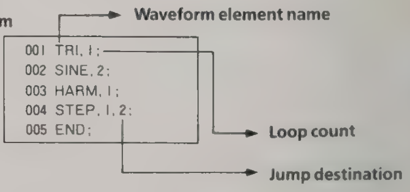
*You begin by constructing the waveform elements that form the building blocks of the waveform to be generated. The 32,000/channel memory can be divided into sections to store up to 16 waveform elements. Each waveform element can consist of any arbitrary number of points, from 10 to 16,000.*



*2. Sequence Program Construction:*

*Sequence programs are created to repeat and link the waveform elements held in memory, during output. The repetition loop count can be set for 1 to 65,535 times, or for an endless loop. You can toggle the sequence sync output (TTL level) to synchronize the analog or digital outputs. The memory of the AG1200 can hold as many as 12 independent sequence programs in memory at one time.*

**Example of a sequence program**



```
001 TRI, 1;
002 SINE, 2;
003 HARM, 1;
004 STEP, 1, 2;
005 END;
```

# Specifications

*Standard Operating Conditions: 23 ± 2°C, 50 ± 10% RH, minimum warmup time of 30 minutes.*

*Other conditions, except where otherwise specified: No load, DC offset addition 0 V, filter OFF, output attenuator at 1/1, external analog addition OFF, clock at 10 MHz.*

## Analog output (general)

**Output channels**

| | |
|---|---|
| 1 | 705110 |
| 2 | 705120 |
| 4 | 705140 & 705142 |

**Maximum output voltage**
± 10V (no load)

**Output impedance**
50 Ω ± 5% (DC)

**Output resolution**
12 bits

**Load resistance**
≧40 Ω

**DC offset addition**
Setting range
≦ ± 10V (resolution of 1 mV)
Accuracy
≦ ± (0.5% of setting value + 5 mV)

**External analog addition**

**Input voltage range**
≦ ± 10V

**DC addition accuracy**
≦ ± (0.5% of input voltage + 10 mV)

**Voltage gain**
1.0

**Frequency characteristics**
DC to 5 MHz (+ 0.5 dB/-3 dB)

**Input resistance**
100k Ω ± 5% (DC)

**Input channels**

| | |
|---|---|
| Channel 1 | (7051 10) |
| Channels 1 & 2 | (7051 20) |
| Channels 1 to 4 | (7051 40) |
| Channels 1 & 2 | (7051 42) |

## Arbitrary waveform output

**DC accuracy**
≦ ± (0.3% of setting value + 15 mV + FSATT accuracy)

**DC stability**
≦ ± (300 ppm of setting + 2 mV)/°C

**Full-scale setting attenuator (FSATT) dB setting**
Two setting methods selectable:
< 1 > Set as full-scale dB (reference 10V)
< 2 > Set as full-scale voltage

**Setting range**
0 to 60 dB (0.001 dB resolution)

**DC accuracy**
± (0.5% of setting value [dB] + 0.02 dB)

**Filter (LPF)**

**Selections**
500k/1M/2M/5M/SHARP (2.7MHz)/OFF

**Overshoot**
5% of maximum amplitude (except SHARP and OFF)

**Rise time**
≦ 70ns (10 to 90%, filter OFF)

**Interchannel skew**
≦ ± 25ns (referenced to CH1, filter OFF)

**Interchannel crosstalk (reference)**
-70 dB

**Output noise (reference)**
Clock components
-37 dBm (50 Ω load)
Non-clock components
-70 dBm (50 Ω load)
Whiteness (40 Hz to 5 MHz)
1 mV rms (50 Ω load)

## Internal clock

**Clock rate**
10 mHz to 10 MHz

**Resolution**
10 mHz

**Accuracy**
± 50 ppm (@ 100 mHz res.)

**Jitter**
≦ 800 ps rms (when 40 kHz to 10 MHz)
≦ 40 ppm rms of period set (when 10 mHz to 40 kHz)
Above is applicable only when clock sweep is not in use.
Phase detection bandwidth of 50 Hz to 15 kHz.

**Clock sweep**
Arbitrary waveform programmable clock sweep.
Sweep forms: Linear, log, or arbitrary sweep

## Internal memory

**Waveform memory**
32000 words/channel
Up to 16 waveform types can be set up at any one time, with sizes ranging from 10 to 16000 words per waveform

**Sequence memory**
255 steps

**Event memory**
32000 W (1 bit/W)

## Auxiliary input/output

**CLOCK-IN**
TTL or AC input, 10 kΩ impedance
TTL: 10 MHz Maximum
Usage: external clock, synchronized operation

**CLOCK-OUT**
TTL output
Usage: synchronized operation

**TRIG-IN**
TTL input, 20 kΩ Impedance
Usage: external trigger, synchronized operation

**TRIG-OUT**
TTL output
Usage: synchronized operation

**RUN/STOP IN**
TTL input, 20 kΩ Impedance
Usage: synchronized operation

**RUN/STOP OUT**
TTL output
Usage: synchronized operation

**SEQ-SYNC**
TTL output (50 Ω serial termination)
Synchronized to sequence operation

**SWP-SYNC**
TTL output (50 Ω serial termination)
Synchronized to sweep start

**EVENT (event output)**
TTL output (50 Ω serial termination)
(synchronized to CH1 waveform element)

## Function generator output

**Output channel**
Individually selectable for each channel

**System**
Synthesizer system (frequency and waveform independently selectable for each channel)

**Waveform types**
Sine, square, triangle, ramp

**Frequency (or period setting)**
10 mHz to 2 MHz (sine waveform)
10 mHz to 200 kHz (other than sine)
10 mHz resolution

**Frequency accuracy**
≦ ± 50ppm (Freq. setting)

**Jitter**
≦ 100 ns p-p

**Interchannel delay**
Can be set in increments of 0.1 degree (except in Model 705110)

## Interfaces

**GPIB**
Conforming to IEEE Standard 488 1978
Interface codes: SH1, AH1, T6, L3, SR1, RL1, PP0, DC1, DT1, C1, C2, C3, C4, C27

**Printer output**
Compatible with Centronics specifications.
Compatible with Epson LQ Series

## General specifications

**Display**
9-inch CRT (amber phosphor)

**Floppy Disk**
3.5 inch floppy disk drive
Format supported: MS-DOS IBM 200 (720KB)

**Operating temperature range**
5 to 40°C (41 to 104°F)

**Humidity range**
20 to 80% RH (29°C maximum wet-bulb temperature)

**Power**
90 to 250 V AC, 48 to 63 Hz

**Power consumption**
300 VA maximum

**Weight (Approx.)**
13 kg (Model 7051 42), 28 lbs

**Dimensions (Approx.)**
177 (H) x 426 (W) x 441 (D) mm, 7 x 16¾ x 17⅜"

## Digital output

**Output channels**
Channels 3 and 4 are each individually selectable for digital output (PG) or analog output (arbitrary, or function generator)

**Output bits**
[16 bits + STRB (clock) x 1] per channel

**Waveform**
NRZ waveform synchronized to clock rate

**Output levels**
CMOS level output (100 Ω serial termination)

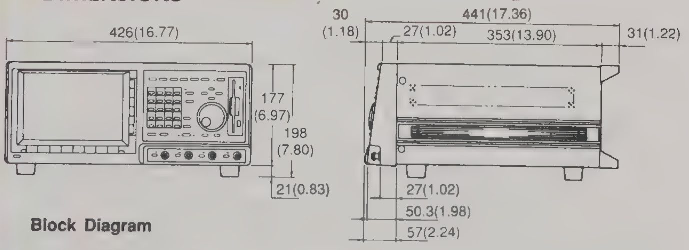
**Output current**
≦ 10 mA/bit

**Load resistance**
≧ 1 kΩ

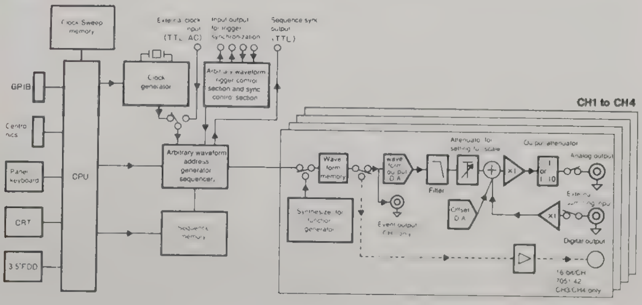
**Reverse-applied voltage**
0 V minimum, 5 V maximum

## DIMENSIONS

Unit:mm (inch)



### Block Diagram



## *MODEL AND SUFFIX CODES*

| Model | | Suffix Codes | | Description |
|---|---|---|---|---|
| 7051 | | | | AG1200 Arbitrary Waveform Generator |
| No. of Channels | 10 | | | AG1200 (1 channel: single analog output). |
| | 20 | | | AG1200 (2 channel: two analog output). |
| | 40 | | | AG1200 (4 channel: four analog output). |
| | 42 | | | AG1200 (4 channel: two analog output + two analog / digital selectable |
| Power Requirements | | -0 | | 90 to 250 VAC |
| Power Cord | | | /D | UL Standard |
| | | | /F | VDE Standard |
| | | | /H | SAA Standard |
| | | | /J | BS Standard |
| | | | /M | JIS Standard (UL + adaptor) grounded cable |
| Floppy Disk Drive | | | /2DD | IBM format 2DD (720KB) |

*Standard Accessories: (2) 3.5'' sample disks. (1) printer cable, (1) power cord, (1) AG1200 Instruction manual, (1) GP-IB Instruction manual*

## *OPTIONAL ACCESSORIES FOR AG1200*

| Code | Name | Order Q'ty |
|---|---|---|
| 366924 | BNC cable (BNC-BNC, 1m) | 1 unit<br>(1 pc./unit) |
| 366925 | BNC cable (BNC-BNC, 2m) | |
| 366926 | BNC cable (with alligator clip) | |
| 705931 | Interface cable for printer | |
| 366921 | Conversion adaptor with BNC plug and banana jack | |
| 366927 | Conversion adaptor with BNC plug and RCA jack | |
| 366928 | Conversion adaptor with BNC jack and RCA plug | |
| 366923 | T-shaped adaptor for parallel connection | |
| 705920 | 50 Ω terminator for parallel connection | |
| 705940 | Digital output connector (36-pin, male, soldered type) | |
| 705922 | Parallel connection kit for two generators | |
| 705923 | Parallel connection kit for three generators | |
| 705924 | Parallel connection kit for four generators | |
| 700921 | Cleaning kit for CRT | |
| 705913 | Data conversion package | |
| 705914 | Data transfer utility (common to AG1200 and AG2000 Series) | |

## Other fine products from YOKOGAWA

YOKOGAWA

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Represented by:

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YOKOGAWA

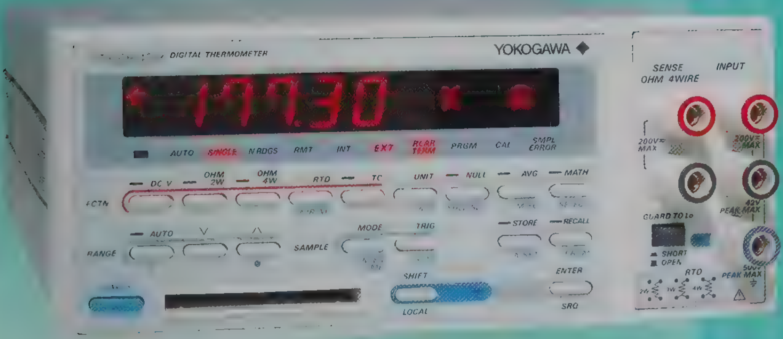
# 7563 DIGITAL THERMOMETER

3 Measuring Functions : Temperature(RTD and TC),
DC V and OHM

High Accuracy : 0.005%(TC), 0.003%(DC V)

High Resolution : 0.01°C/0.01°F(RTD), 100nV(DC V)

High-Speed Sampling : 100 times/s(4-1/2 digit display)



# DIGITAL THERMOMETER

Bulletin 7563-E

# Precision Digital Thermometer for the R & D, Biometeorology, Medical Science & Energy Saving.

The Model 7563 Digital Thermometer has 16 ranges of temperature sensors and measuring function of DC V and Ω. YOKOGAWA-original A-D converter (feedback pulse width modulation method) features the superior noise immunity, stability and high-speed sampling. In addition, versatile functions are suitable for system use and covers a wide variety of applications from test to R & D.

## High accuracy, high resolution and high-speed sampling

**Temperature measurement:**
**Accuracy: 0.005%(TC), 0.009%(RTD)**
**Resolution: TC...0.1°C(0.1°F), RTD...0.01°C(0.01°F)**
**DC V measurement:**
**Accuracy: 0.003%(2,000 mV range)**
**Resolution: 100 nV(200 mV range)**
**Ω measurement:**
**Accuracy: 0.005%(2,000 Ω range)**
**Resolution: 100 μΩ(200 Ω range)**
**Sampling rate:**
**Max. 100 times/s (4-1/2 digits)**

For the temperature measurement (RTD), high resolution of 0.01°C (0.01°F) can be obtained. In DC V and resistance measurement, the resolution of 100 nV and 100 μΩ can be obtained with high stability (Figure 1).
In addition, the high-speed sampling rate of up to 10 ms are available for the study of biometeorology/medical, development of electronic components where the rapid and precise temperature measurement are required.

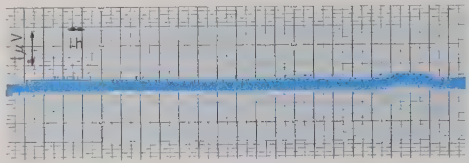


Figure 1 Drift data (zero point of DC V)

## 3 measuring functions: Temperature, DC V and resistance

4 types of RTD's (2-wire/3-wire/4-wire) and 12 types of TC's, are available to be used in a wide range of applications.
In addition, the DC V and resistance (2-wire/4-wire) measuring functions are also available in a single instrument.
TC : 12 types (R, S, B, K, E, J, T, L, U, N, W and KP vs Au7Fe)
RTD : 4 types (Pt100, JPt100, Pt1000 and J263*B)

## High-accuracy reference junction compensation: Compensation accuracy (±0.2°C)

Input terminals are provided on both front and rear panels, and an input site is switch selectable. The rear panel input terminal has an isothermal structure, and it is provided with windbreak cover of one-touch type. The 7563 uses YOKOGAWA-original transistor temperature sensor in the reference junction compensation circuit. A compensation accuracy of ±0.2°C(±0.4°F) is realized together with the isothermal structure of the input terminal. (Figure 2)

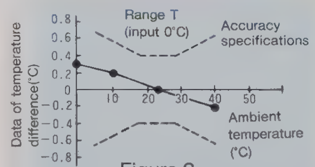


Figure 2
Temperature characteristics

## Memory card

Memory card expands application capability. It is possible to save the measured data of up to 8000 data as a buffer memory. It also allows you to save the panel setting conditions and read it automatically at power ON (AUTO LOAD). In addition, measuring parameters can be programmed up to 20 steps into the memory card.

## GPIB or RS-232-C interface (standard)

The 7563 incorporates bidirectional communication function which supports the system use. Not only the measured data output, but also the all functions executed by panel key operation can be controlled excluding only the power supply ON/OFF operation from a host computer by powerful set of commands.

## Multi-point measurement of up to 50 points

By using a programmable scanner **750101** (to be available in 2nd half of 1990), the multi-point measurement of up to 50 points will be possible. Similarly, up to 10 points will be possible by using a **750201** (to be available in 1991).

## Adjustment function of Ro : Reference resistance value of RTD (at 0 C)

Adjustment function of $R_0$ expands the 7563's input ranges.
As adjustment range of this function covers 0 to 2,000 Ω with 0.001 Ω resolution, the combination of this function and three ranges for Pt RTD sensor offers customer to use almost all types of RTD sensor in the world.

## Two types of external reference junction compensation (RJC)

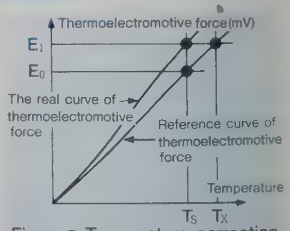
- **External RJC with adjustable reference junction temperature**
  This function means that user can use any type of reference temperature, such as $H_2O$(t), He(v), $O_2$(t), Hg(t), Ga(m), Sn(f), Au(f), etc. Adjustment range covers all temperature range of 12 thermocouples with 0.1°C(0.1°F) resolution.
- **Remote RJC utlizing Pt100 sensor (Program Mode)**
  In this mode, Pt100 sensor measures the temperature of external input terminal, and the 7563 compensates the reference junction temperature of the thermocouple connected to the external input terminal.

## Analog output (optional)

This optional feature specify any data of 3-1/2 or 3 digits on the display and converts it to the analog data with the range of ±500mV or ±1V.
This function is ideal for both long-time temperature measurement and small change of measurement.

## Versatile mathematical functions

In addition to the noise elimination function by moving average function and offset compensation (NULL), the scaling function and comparator function are also available.
(Example) When TC is calibrated at a reference temperature (Ts), the correction for measured value (Tx) can easily be obtained by using the scaling function. (Figure 3).
Scaling function : (X-A)/B, provided that, A=0, B=Tx/Ts


Thermoelectromotive force(mV)
$E_1$
$E_0$
The real curve of thermoelectromotive force
Reference curve of thermoelectromotive force
Temperature
$T_S$
$T_X$
Figure 3 Temperature correction by means of the scaling function

## Software calibration

Calibration of DC V and Ω can be executed by simple panel key operation or via communication interfaces.
Calibration values for temperature measurement ranges are automatically calculated by only giving reference inputs for DC V and Ω ranges.

# SPECIFICATIONS

## 1. DC Voltage (DC V)

**●Ranges**

＊16.7ms shows 16.66

| Range | Integrating time (500/200ms) |  | Integrating time (100/20/16.7ms)＊ |  | Integrating time (2.5ms) |  | Input Resistance | Max. Input |
|---|---|---|---|---|---|---|---|---|
|  | Max. Reading | Resolution | Max. Reading | Resolution | Max. Reading | Resolution |  |  |
| 200mV | 199.9999 | 100nV | 199.999 | 1μV | 199.99 | 10μV | >1GΩ | ±200V peak between Hi and Lo,<br>±42V peak between Lo and guard,<br>±500V peak between Guard and case. |
| 2000mV | 1999.999 | 1μV | 1999.99 | 10μV | 1999.9 | 100μV |  |  |
| 20V | 19.99999 | 10μV | 19.9999 | 100μV | 19.999 | 1μV |  |  |
| 200V | 199.9999 | 100μV | 199.999 | 1mV | 199.99 | 10mV | 10MΩ ±1% |  |

**●Accuracy (Integrating time 100ms) : ±(% of reading + digits)**

| Range | 24h, 23±1°C | 90days, 23±5°C | 1year, 23±5°C | Temperature Coefficient (/°C＊) |
|---|---|---|---|---|
| 200mV | 0.004 +20(3) ¦4¦ | 0.005+25(4) ¦4¦ | 0.007+25(4) ¦4¦ | 0.0006+5(.6) ¦.2¦ |
| 2000mV | 0.0025 + 8(2) ¦3¦ | 0.003+10(2) ¦3¦ | 0.005+10(2) ¦3¦ | 0.0004+1 (.2) ¦.1¦ |
| 20V | 0.003 + 8(2) ¦3¦ | 0.004+10(2) ¦3¦ | 0.006+10(2) ¦3¦ | 0.0005+1 (.2) ¦.1¦ |
| 200V | 0.0045+10(2) ¦3¦ | 0.008+15(2) ¦3¦ | 0.015 + 15(2) ¦3¦ | 0.0007+1 (.2) ¦.1¦ |

＊ Temperature range : 5 to 18, 28 to 40°C

- ●Accuracy at 24 hours, 23±1°C is the value for calibration standard.
- ●Auto Zero ON, Null.
- ●Integrating time: At 200ms, 2 is added to the value (digits) in integrating time 500ms.
- ●( ) indicates the value (digits) in integrating time 100ms. At 20 16.7ms, 2 is added to the value (digits) in integrating time of ( ).
- ●¦ ¦ indicates the value (digits) in integrating time 2.5ms.
- ●At Auto Zero OFF, temperature coefficient of ±(0.0015% of range ±25μV)/°C is added (at 5 to 40°C).
- ●Common Mode Rejection: 120dB or more. Integrating time: 500 200 100 20 16.7ms, Rs−1kΩ, 50 60Hz ±0.1% (Rs: signal source resistance).
- ●Normal Mode Rejection: 60dB or more. Integrating time: 500 200/100/20/16.7ms, 50/60Hz ±0.1%.

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## 3. Temperature (TC)

| ＊1. Range | Measurement range |  | Resolution | ＊2. Accuracy (Integrating time 500/200/100/20/16.7): ±(% of rdg + °C) |  |  |
|---|---|---|---|---|---|---|
|  |  |  | 500/200ms | 24hours, 23 ±1 ＊4 | 90days, 23 ± 5°C ＊4 | 1 year, 23 ± 5°C ＊ |
| R | −50.0 to 0°C<br>0.0 to 100.0°C<br>100.0 to 600.0°C<br>600.0 to 1,760.0°C | −58.0 to 32.0°F<br>32.0 to 212.0°F<br>212.0 to 1,112.0°F<br>1,112.0 to 3,200.0°F | 0.1°C (0.1°F)<br>0.1°C (0.1°F)<br>0.1°C (0.1°F)<br>0.1°C (0.1°F) | 0.005 +0.5 ¦0.7¦<br>0.005 +0.4 ¦0.5¦<br>0.005 +0.3 ¦0.4¦<br>0.005 +0.2 ¦0.3¦ | 0.006 +0.5 ¦0.7¦<br>0.006 +0.4 ¦0.5¦<br>0.006 +0.3 ¦0.4¦<br>0.006 +0.2 ¦0.3¦ | 0.008 +0.5 ¦0.7¦<br>0.008 +0.4 ¦0.5¦<br>0.008 +0.3 ¦0.4¦<br>0.008 +0.2 ¦0.3¦ |
| S | −50.0 to 0°C<br>0.0 to 100.0°C<br>100.0 to 600.0°C<br>600.0 to 1,760.0°C | −58.0 to 32.0°F<br>32.0 to 212.0°F<br>212.0 to 1.112.0°F<br>1,112.0 to 3,200.0°F | 0.1°C (0.1°F)<br>0.1°C (0.1°F)<br>0.1°C (0.1°F)<br>0.1°C (0.1°F) | 0.005 +0.6 ¦0.7¦<br>0.005 +0.4 ¦0.5¦<br>0.005 +0.3 ¦0.4¦<br>0.005 +0.2 ¦0.3¦ | 0.006 +0.6 ¦0.7¦<br>0.006 +0.4 ¦0.5¦<br>0.006 +0.3 ¦0.4¦<br>0.006 +0.2 ¦0.3¦ | 0.008 +0.6 ¦0.7¦<br>0.008 +0.4 ¦0.5¦<br>0.008 +0.3 ¦0.4¦<br>0.008 +0.2 ¦0.3¦ |
| B | 0.0 to 42°C<br>42.0 to 100.0°C<br>100.0 to 200.0°C<br>200.0 to 300.0°C<br>300.0 to 400.0°C<br>400.0 to 1,820.0°C | 32.0 to 107.6°F<br>107.6 to 212.0°F<br>212.0 to 392.0°F<br>392.0 to 572.0°F<br>572.0 to 752.0°F<br>752.0 to 3,308.0°F | —<br>0.1°C (0.1°F)<br>0.1°C (0.1°F)<br>0.1°C (0.1°F)<br>0.1°C (0.1°F)<br>0.1°C (0.1°F) | —<br>0.005 +7.0 ¦9.0¦<br>0.005 +1.5 ¦2.0¦<br>0.005 +1.0 ¦1.2¦<br>0.005 +0.7 ¦0.9¦<br>0.005 +0.3 ¦0.4¦ | —<br>0.006 +7.0 ¦9.0¦<br>0.006 +1.5 ¦2.0¦<br>0.006 +1.0 ¦1.2¦<br>0.006 +0.7 ¦0.9¦<br>0.006 +0.3 ¦0.4¦ | —<br>0.008 +7.0 ¦9.0¦<br>0.008 +1.5 ¦2.0¦<br>0.008 +1.0 ¦1.2¦<br>0.008 +0.7 ¦0.9¦<br>0.008 +0.3 ¦0.4¦ |
| K | −270.0 to −250.0°C<br>−250.0 to −200.0°C<br>−200.0 to 0.0°C<br>0.0 to 1,370.0°C | −454.0 to −418.0°F<br>−418.0 to −328.0°F<br>−328.0 to 32.0°F<br>32.0 to 2,498.0°F | 0.1°C (0.1°F)<br>0.1°C (0.1°F)<br>0.1°C (0.1°F)<br>0.1°C (0.1°F) | 0.004 +1.3 ¦2.5¦<br>0.004 +0.5 ¦0.9¦<br>0.004 +0.3 ¦0.4¦<br>0.004 +0.2 ¦0.3¦ | 0.005 +1.3 ¦2.5¦<br>0.005 +0.5 ¦0.9¦<br>0.005 +0.3 ¦0.4¦<br>0.005 +0.2 ¦0.3¦ | 0.007 +1.3 ¦2.5¦<br>0.007 +0.5 ¦0.9¦<br>0.007 +0.3 ¦0.4¦<br>0.007 +0.2 ¦0.3¦ |
| J | −210.0 to −200.0°C<br>−200.0 to −150.0°C<br>−150.0 to 0.0°C<br>0.0 to 1,200°C | −346.0 to −328.0°F<br>−328.0 to −238.0°F<br>−238.0 to 32.0°F<br>32.0 to 2,192.0°F | 0.1°C (0.1°F)<br>0.1°C (0.1°F)<br>0.1°C (0.1°F)<br>0.1°C (0.1°F) | 0.004 +0.4 ¦0.6¦<br>0.004 +0.3 ¦0.5¦<br>0.004 +0.2 ¦0.4¦<br>0.004 +0.2 ¦0.3¦ | 0.005 +0.4 ¦0.6¦<br>0.005 +0.3 ¦0.5¦<br>0.005 +0.2 ¦0.4¦<br>0.005 +0.2 ¦0.3¦ | 0.007 +0.2 ¦0.6¦<br>0.007 +0.2 ¦0.5¦<br>0.007 +0.2 ¦0.4¦<br>0.007 +0.2 ¦0.3¦ |
| E | −270.0 to −250.0°C<br>−250.0 to −200.0°C<br>−200.0 to 0.0°C<br>0.0 to 1,000.0°C | −454.0 to −418.0°F<br>−418.0 to −328.0°F<br>−328.0 to 32.0°F<br>32.0 to 1,832.0°F | 0.1°C (0.1°F)<br>0.1°C (0.1°F)<br>0.1°C (0.1°F)<br>0.1°C (0.1°F) | 0.004 +0.8 ¦1.5¦<br>0.004 +0.3 ¦0.6¦<br>0.004 +0.2 ¦0.4¦<br>0.004 +0.2 ¦0.3¦ | 0.005 +0.8 ¦1.5¦<br>0.005 +0.3 ¦0.6¦<br>0.005 +0.2 ¦0.4¦<br>0.005 +0.2 ¦0.3¦ | 0.007 +0.8 ¦1.5¦<br>0.007 +0.3 ¦0.6¦<br>0.007 +0.2 ¦0.4¦<br>0.007 +0.2 ¦0.3¦ |
| T | −270.0 to −250.0°C<br>−250.0 to −200.0°C<br>−200.0 to 400.0°C | −454.0 to −418.0°F<br>−418.0 to −328.0°F<br>−328.0 to 752.0°F | 0.1°C (0.1°F)<br>0.1°C (0.1°F)<br>0.1°C (0.1°F) | 0.004 +1.0 ¦1.5¦<br>0.004 +0.3 ¦0.5¦<br>0.004 +0.2 ¦0.3¦ | 0.005 +1.0 ¦1.5¦<br>0.005 +0.3 ¦0.5¦<br>0.005 +0.2 ¦0.3¦ | 0.007 +1.0 ¦1.5¦<br>0.007 +0.3 ¦0.5¦<br>0.007 +0.2 ¦0.3¦ |
| U | −200.0 to −100.0°C<br>−100.0 to 0.0°C<br>0.0 to 600.0°C | −328.0 to −148.0°F<br>−148.0 to 32.0°F<br>32.0 to 1,112.0°F | 0.1°C (0.1°F)<br>0.1°C (0.1°F)<br>0.1°C (0.1°F) | 0.004 +0.3 ¦0.4¦<br>0.004 +0.3 ¦0.4¦<br>0.004 +0.2 ¦0.3¦ | 0.005 +0.3 ¦0.4¦<br>0.005 +0.3 ¦0.3¦<br>0.005 +0.2 ¦0.2¦ | 0.007 +0.3 ¦0.4¦<br>0.007 +0.3 ¦0.4¦<br>0.007 +0.2 ¦0.4¦ |
| L | −200.0 to −100.0°C<br>−100.0 to 900.0°C | −328.0 to −148.0°F<br>−148.0 to 1,652.0°F | 0.1°C (0.1°F)<br>0.1°C (0.1°F) | 0.004 +0.3 ¦0.4¦<br>0.004 +0.2 ¦0.3¦ | 0.005 +0.3 ¦0.4¦<br>0.005 +0.2 ¦0.3¦ | 0.007 +0.3 ¦0.4¦<br>0.007 +0.2 ¦0.3¦ |
| N | 0.0 to 1,300.0°C | 32.0 to 2,372.0°F | 0.1°C (0.1°F) | 0.004 +0.2 ¦0.3¦ | 0.005 +0.2 ¦0.3¦ | 0.007 +0.2 ¦0.3¦ |
| W | 0.0 to 2,315.0°C | 32.0 to 4,199.0°F | 0.1°C (0.1°F) | 0.004 +0.2 ¦0.4¦ | 0.005 +0.2 ¦0.4¦ | 0.007 +0.2 ¦0.4¦ |
| KPvsAu7Fe | 0.0 to 20.0K<br>20.0 to 70.0K<br>70.0 to 300.0K |  | 0.1K<br>0.1K<br>0.1K | ＊2 0.005 +1.3 ¦0.4¦<br>0.005 +0.2 ¦0.3¦<br>0.005 +0.2 ¦0.2¦ | ＊2 0.006 +0.3 ¦0.3¦<br>0.006 +0.2 ¦0.2¦<br>0.006 +0.2 ¦0.2¦ | ＊2 0.009 +0.3 ¦0.3¦<br>0.004 +0.2 ¦0.2¦<br>0.009 +0.2 ¦0.2¦ |

＊1. As to the R, S, B, K, J, E and T, the provisions of JIS C1602-1981 apply. As to the U and L, those of DIN43710 apply. As to the N, those of IEC584, DIN IEC584 apply. As to the W, those of Hoskins Mtg CO (USA) apply. As to the KpvsAu7Fe, those of NSB Vol. 76A apply.

＊2. KPvsAu7Fe: ±(% of rdg+K) ＊3. KPvsAu7Fe: ±(% of rdg+K)/°C ＊4. In case of accuracy and temperature coefficient of °F, multiply 1.8×°C.

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## 4. Temperature (RTD)

| ※1. Range | Measurement range | Resolution | Current through unknown | ＊2. Accuracy (Integrating time |  |
|---|---|---|---|---|---|
|  |  | 500/200/100ms |  | 24hours, 23±1°C ＊4 | 90days, |
| Pt100 | −200.00 to 650.00°C (−328.00 to 1,202.00°F) | 0.01°C (0.01°F) | 1mA | 0.005 + 0.07<br>(0.1) ¦0.3¦ | 0.009<br>(0.1) |
| JPt100 | −200.00 to 510.0°C (−328.00 to 950.00°F) | 0.01°C (0.01°F) | 1mA | 0.005 + 0.07<br>(0.1) ¦0.3¦ | 0.009<br>(0.1) |
| Pt1000 | −200.00 to 650.00°C ( 328.00 to 1,202.00°F) | 0.01°C (0.01°F) | 0.1mA | 0.005 · 0.05<br>(0.07) ¦0.2¦ | 0.009<br>(0.07 |
| J263＊B | 2.0 to 300.0K | 0.1K | 1mA | ＊2 0.005 + 0.1<br>(0.1) ¦0.2¦ | ＊2 0.011<br>(0.1) |

＊1. As to Pt100 and JPt100, JIS C1604-1989 and JIS C1609-1989 apply. As to Pt1000, the prescription for Pt100 of JIS C1604-1989 applies

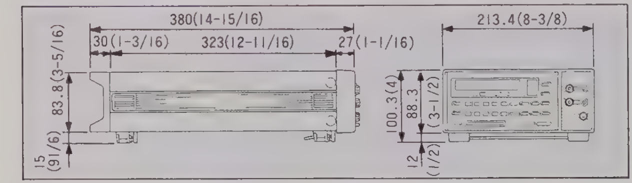
＊2. J263＊B: ±(% of rdg+K) ＊3. J263＊B: ±(% of rdg+K)/°C ＊4. In case of accuracy and temperature coefficient of °F, multiply 1.8×°C.

## General Specifications

Operating Principle : Feedback pulse width modulation method.
Sample Mode : Auto/Single/N reading.
Maximum Reading : 1999999.
Overrange Information : -oL- sign display.
Data Memory : 1,000 data, measured data can be stored and recalled : (STORE/RECALL).
Ranging : AUTO, MANUAL, (remote control and programming possible).
Analog Output (D-A converter) : Optional.
Burnout : TC burnout (defective connection or disconnection etc.) is automatically checked and indicated by alarm display (ON or OFF selectable).
2kΩ or less (normal), if the value is higher than 30kΩ, the connection is cut down. Current 2.2μA or so. Pulse width detection; 2.4ms or so.
Interface
GPIB Interface
Electrical & Mechanical Specifications : Conforms to IEEE St'd 488-1978.
Interface Function & Identification : SH1, AH1, L4, SR1, RL1, PP0, DC1, DT1, C0. Address Mode, address and header ON/OFF can be settable.
RS-232-C Interface
Transmission System : Start-stop system.
Data Transfer Rates : 75, 150, 300, 600, 1200, 2400, 4800, 9600 bps. Hand Shake Mode, bps rate, NO. of bits and header ON/OFF can be settable.
Operating Temperature Range : 5 to 40°C (41 to 104°F).
Humidity Range : 20 to 80% relative humidity.
Warmup Time : Approx. 60 minutes to rated accuracy.
Power Requirements : 100/115 V AC ±10% (100/115V : selectable by switch), 50 or 60Hz (200/230V must be specified, selectable)
Power Consumption : 20 VA max.
Dimensions (Approx.) : 88(H)×213(W)×350(D)mm, (3-1/2×8-3/8×13-15/16").
Weight (Approx.) : 3 kg (6.6 lbs).
Standard Accessories : Power supply cord 1 set, shielded test lead (B9409LA) 1 set, 0.2 A fuse (time lag) 1 pc., remote connector 1 pc., instruction manual 1 copy.

## Dimensions

Unit: mm(inch)



## Model, Suffix and Option Codes

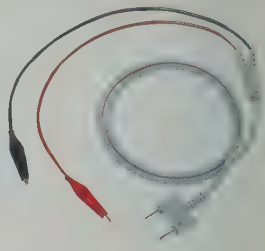
| Model | Suffix Codes | | | | Description | |
|---|---|---|---|---|---|---|
| 756301 | | | | | 6.5 digits | DCV, OHM, TEMP (TC & RTD) (GPIB) |
| 756302 | | | | | | DCV, OHM, TEMP (TC & RTD) (RS-232-C) |
| | -A | | | | Always **A** (version code) | |
| Power Requirements | | -1 | | | 100V AC (50 & 60Hz), 115V AC changable | |
| | | -3 | | | 115V AC (50 & 60Hz), 100V AC changable | |
| | | -5 | | | 200V AC (50 & 60Hz), 230V AC changable | |
| | | -7 | | | 230V AC (50 & 60Hz), 200V AC changable | |
| Power Cord | | | /B | | JIS standard | |
| | | | /D | | UL standard | |
| | | | /F | | VDE standard | |
| | | | /G | | SAA standard | |
| Optional feature | | | | /DA | D-A converter | |

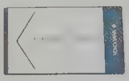
## Optional Accessories

| Name | Code | Description |
|---|---|---|
| Memory card (8K bytes) | 378901 | Setting & measured data |
| Memory card (16K bytes) | 378902 | Setting & measured data |
| Memory card (64K bytes) | 378903 | Setting & measured data |
| Dummy card | B9586NG | Dust cap for memory card slot |
| Shielded test leads | B9409LA | Alligator type, 0.8m |
| Rack mounting kit | 751501 | EIA (single mounting) |
| Rack mounting kit | 751502 | EIA (double mounting) |
| Rack mounting kit | 751503 | JIS (single mounting) |
| Rack mounting kit | 751504 | JIS (double mounting) |
| 4-wire resistance measuring lead | 751510 | 0.6m |

4-wire resistance measuring lead(751510)

Shielded test leads(B9409LA)





Memory card
(378901, 378902, 378903)

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# 2543
# Portable Printer

## Compact, One-Point Data Logger with Built-in A-D Converter

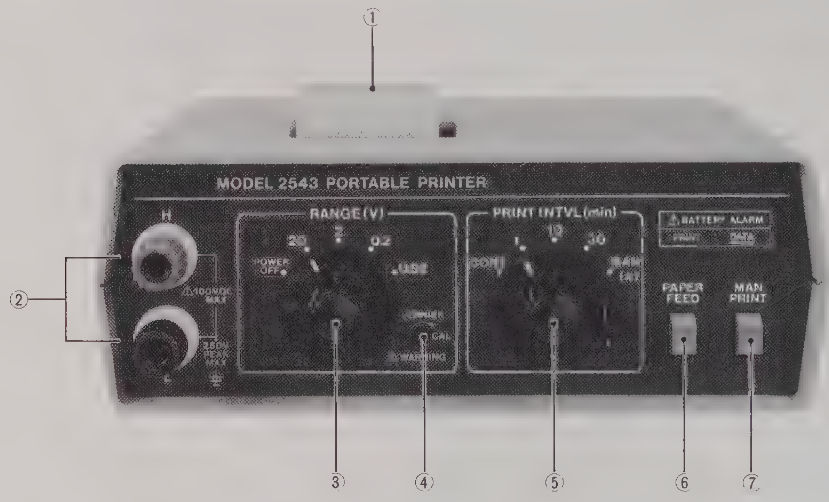
Model 2543 Portable Printer is a compact, stand-alone unit that accepts inputs from 20 mV to 100 V, and provides permanent record of digital data. It includes an A-D converter, thermal printer and quartz clock. Compact, lightweight and easy to operate, Model 2543 features manual or automatic printout with or without scaling, an adjustable decimal point, and engineering unit combination setting, among other features.

Model 2543 can be connected to a wide range of instruments providing an analog output, and used for a variety of laboratory and industrial applications.

## MAIN FEATURES

- **4 input ranges — 20mV, 200mV, 2V, 20V DC (accepts inputs up to 100V)**
- **Max. resolution — 10 $\mu$V**
- **Front-panel VERNIER for scaling of input from 1 to approx. 10 times**
- **Decimal point and engineering units setting, plus scaling function allow direct printout/readout in engineering terms**
- **Print interval selector — continuous (3s), 1 min, 10 min, 30 min or manual**
- **Automatic printout of elapsed time by an internal quartz clock**
- **Battery/power line operation**
  Standard 1.5 batteries supply up to 100 hours of continuous operation. Power line operation is available as an option.
- **Compact and lightweight — only 1.1 kg (2.4 lbs) including batteries**

## PANEL LAYOUT AND FUNCTIONS



*Front Panel*

① **Printer paper**

② **Input terminals**
Accepts input up to 100 V DC (on 20 V range, and with VERNIER at x 10).

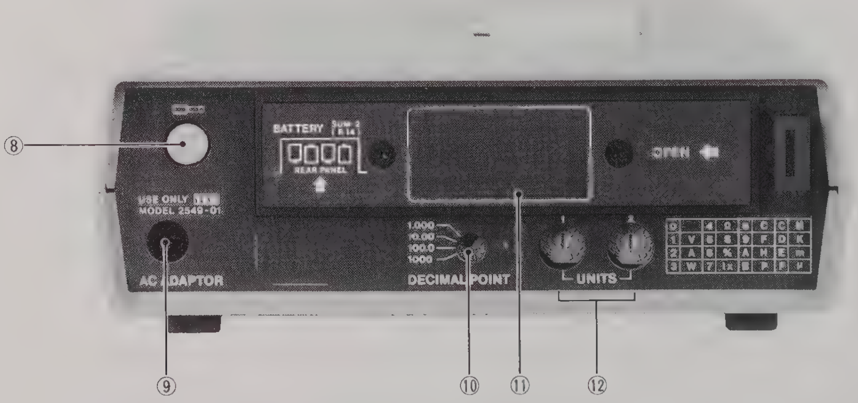
③ **Range selector dial**
Four ranges of 0.02 V, 0.2 V, 2 V and 20 V DC, and POWER OFF.

④ **Scaling VERNIER**
x 1 to approx. x 10 of input (continuously variable). Max. input 100 V DC.

⑤ **Print interval selector dial**
Automatic printout . . .Continuous (3s), 1 min, 10 min or 30 min print interval.
Manual printout . . .Set to MAN, it prints only when the MAN PRINT button is depressed.

⑥ **PAPER FEED button**

⑦ **MAN PRINT button**
Used for manual printout.



*Rear Panel*

⑧ **Screwdriver compartment**
A convenient storage compartment for an accessory screwdriver used to set VERNIER, units and decimal point.

⑨ **AC ADAPTER receptacle**

⑩ **DECIMAL POINT setting switch**
Settable to any of four positions. When used with scaling function, it allows readout directly in engineering terms.

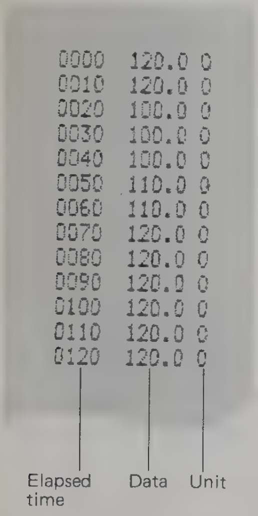
⑪ **Battery compartment**
Stores four 1.5 V batteries.

⑫ **UNITS setting switches**
Any two characters are selectable from 16 symbols as listed in the right table.

## EXAMPLES OF PRINTOUTS

*(Actual size)*

**Automatic printout**

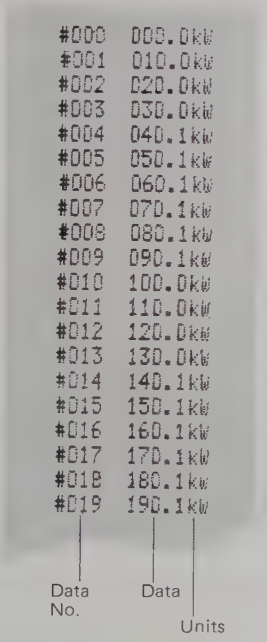


```
0000  120.0 0
0010  120.0 0
0020  100.0 0
0030  100.0 0
0040  100.0 0
0050  110.0 0
0060  110.0 0
0070  120.0 0
0080  120.0 0
0090  120.0 0
0100  120.0 0
0110  120.0 0
0120  120.0 0
```

Elapsed time
Data
Unit

Print interval: 10 minutes.

**Manual printout**

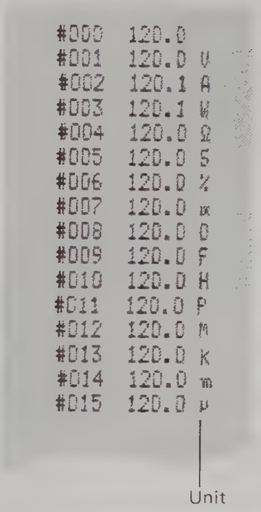


```
#000  000.0kW
#001  010.0kW
#002  020.0kW
#003  030.0kW
#004  040.1kW
#005  050.1kW
#006  060.1kW
#007  070.1kW
#008  080.1kW
#009  090.1kW
#010  100.0kW
#011  110.0kW
#012  120.0kW
#013  130.0kW
#014  140.1kW
#015  150.1kW
#016  160.1kW
#017  170.1kW
#018  180.1kW
#019  190.1kW
```

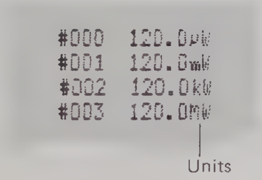
Data No.
Data
Units

Manual printout is distinguished from automatic printout by # mark.

**Engineering units**



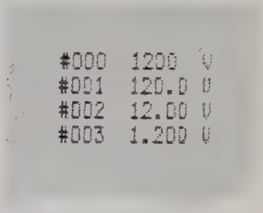
```
#000  120.0
#001  120.0 V
#002  120.1 A
#003  120.1 W
#004  120.0 Ω
#005  120.0 S
#006  120.0 %
#007  120.0 ∞
#008  120.0 D
#009  120.0 F
#010  120.0 H
#011  120.0 P
#012  120.0 M
#013  120.0 K
#014  120.0 m
#015  120.0 μ
```



```
#000  120.0μW
#001  120.0mW
#002  120.0kW
#003  120.0MW
```

As the engineering unit(s), any two characters are selectable from 16 symbols.

**Decimal point setting**



```
#000  1200  V
#001  120.0 V
#002  12.00 V
#003  1.200 V
```

Decimal point is settable to any of four positions

## EXAMPLES OF APPLICATIONS

To provide a permanent record of digital data, Model 2543 can be connected to a wide variety of instruments which output DC signal. Described are some examples of YEW's combination instruments.

| Variable to be Printed | Combination Instruments (Model) |
|---|---|
| Temperature<br>Humidity<br>Pressure | 2572 Digital thermometer<br>2575 Digital thermometer<br>2577 Digital hygrometer<br>2654 Digital manometers<br>2804 Digital resistance thermometer |
| Power | 2433 Clip-on AC power meter<br>2503 Digital AC power meter<br>2504 Digital AC meter<br>2505 Digital AC meter |
| AC voltage<br>AC current<br>Power factor<br>Reactive power<br>Frequency | 2280 Power line transducers |
| Magnetic flux | 3251 Gauss meter<br>3254 Electronic fluxmeter |
| Illuminance | 3281 Portable luxmeter<br>3286 Portable luxmeter |

## SPECIFICATIONS

**Number of Channels:** 1.
**Input:** 0 to ±20 V DC (with VERNIER set to CAL), or up to 100 V DC (attenuated to 20 V using VERNIER). Input can be scaled from 1 to approx. 10 times by adjusting VERNIER.
**RANGE Selector:** 0.02, 0.2, 2 and 20 V DC.
**Accuracy:** ±(0.15% of reading + 0.1% of range), at 23±5°C and VERNIER at CAL.
**Temperature Coefficient:** ±(0.015% of reading + 0.01% of range)/°C, with VERNIER at CAL.
**Input Impedance:** Approx. 1MΩ (or more than 90 kΩ at POWER OFF or overrange).
**Engineering Units:** Any of two of the following 16 symbols can be combined (manual setting on rear-panel switches) . . . space, V, A, W, Ω, S, %, 1x, C, F, H, P, M, k, m, μ.
**Decimal Point:** Manual setting on rear-panel switch to any of four positions.
**Print Interval:** Selectable by front-panel PRINT INTVL dial . . . continuous (CONT), 1, 10 or 30 minutes, or manual (MAN).
**Paper:** Thermal sensitive, in rolls with data capacity of approx. 2,000 lines/roll (five rolls supplied).
**Character Height:** Approx. 2 mm.
**Maximum Print Data:** 1999.
**Overrange:** **** printed instead of data.
**Maximum Allowable Input:** 100 V peak.
**Maximum Common Mode Voltage:** 250 V peak.
**Common Mode Rejection:** More than 80 dB at 50 or 60 Hz with 1 kΩ source impedance unbalance.
**Normal Mode Rejection:** More than 40 dB at 50 or 60 Hz.
**Insulation Resistance:** More than 50 MΩ at 250 V DC between input terminals (H, L shorted) and rear panel, and between input terminals and handle.
**Dielectric Strength:** 1,500 V AC for one minute between input terminals (H, L shorted) and rear panel, and between input terminals and handle.
**Operating Temperature & Humidity Ranges:** 5 to 40°C (41 to 104°F), 20 to 80% relative humidity.
**Storage Temperature & Humidity Ranges:** −25 to 70°C (−13 to 135°F), 5 to 95% relative humidity.
**Power Requirements:** Battery operation . . . four 1.5 V batteries (JIS SUM-2, ANSI C, Baby 1.5 V or equivalent), approx. 100 hours of continuous operation at print interval of 1 to 30 minutes.
AC line operation . . . 100 V AC±10% by using an optional Code 254901 AC adapter. Other AC voltage operations are available by using a step-down transformer.
**Dimensions:** Approx. 60 x 166 x 207 mm (2-3/8 x 6-1/2 x 8-1/8″).
**Weight:** Approx. 1.1 kg including batteries (2.4 lbs).
**Accessories supplied at no extra cost:** Batteries . . . 4 pcs (built-in), thermal roll paper . . . 5 rolls, screwdriver . . . 1 pc.

### OPTIONAL ACCESSORIES

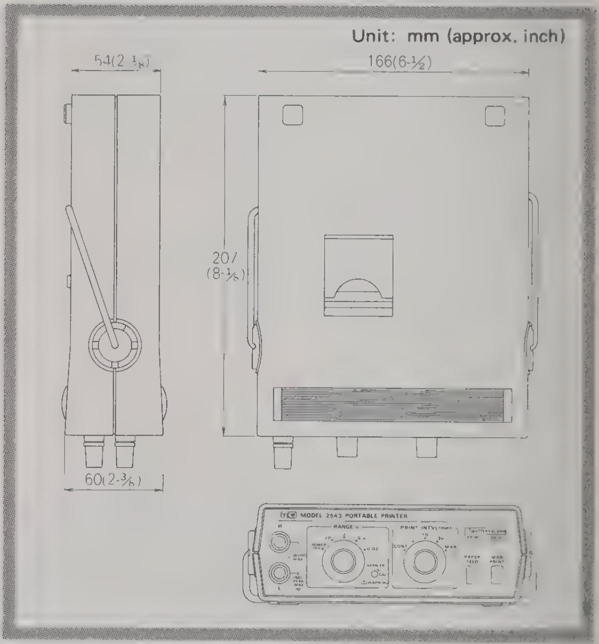
**Code 254901 AC adapter**
100 V AC±10%, 6 V (1A) output.

**Code 289801 Measurement lead**
Lead length: approx. 1.1 m(3.6 ft).

### SPARES

**Code 259901 Thermal roll paper** (5 rolls)

## DIMENSIONS



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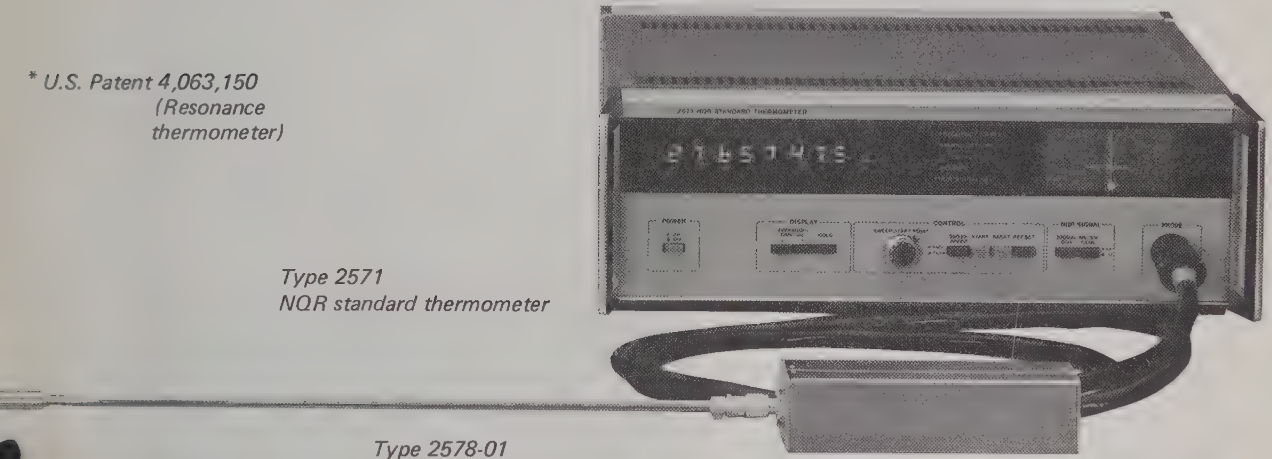
# 2571
# NQR Standard Thermometer

## Fully Automatic Precision Thermometer Using NQR Absorption of $KClO_3$—90 to 398 K with ±1.3 mK Reproducibility

GP-IB

* *U.S. Patent 4,063,150 (Resonance thermometer)*


*Type 2571 NQR standard thermometer*

*Type 2578-01 NQR sensor probe*

The YEW NQR Standard Thermometer, Type 2571, is a digital instrument suitable for use as a primary temperature standard. This thermometer provides exceptionally high accuracy, reproducibility and stability over the temperature range from 90 to 398 K (−183 to +125°C). Its output is a frequency signal. It is interfaced with a computer or programmable calculator to provide a digital temperature readout.

The operating principle is based on the negative temperature coefficient of the nuclear quadrupole resonance (NQR) absorption frequency of the chlorine nucleus $Cl^{35}$ in potassium chlorate $KClO_3$.

Utilizing the inherent nature of resonance-absorption phenomena, recalibration is unnecessary even if probes are changed.

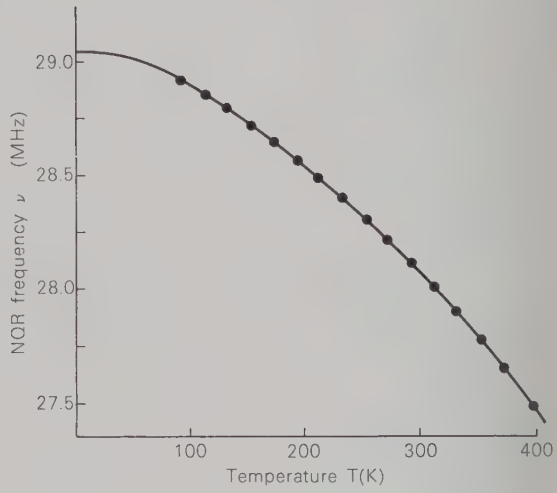
## FEATURES

- **1 Hz (0.2 mK) RESOLUTION**
  From 90 to 398 K, resolution is 1 Hz (corresponds to 0.2 mK). This is exceptionally high performance even for a temperature reference standard.
- **PROBES MATCH WITHIN 10 Hz (2 mK)**
  Different probes match to an accuracy of ±10 Hz (corresponds to ±2 mK) at the triple point of water.
- **ANALOG METER MONITORS NQR SIGNAL**
- **6 Hz (1.3 mK) REPRODUCIBILITY**
  Reproducibility is less than 6 Hz (corresponds to 1.3 mK).
- **NO CALIBRATION REQUIRED**
- **SIMPLICITY OF OPERATIONS**
  The instrument uses a phase-locked loop with frequency sweep to find the NQR absorption frequency and ensure automatic lock-in.

## NUCLEAR QUADRUPOLE RESONANCE (NQR) IN $KClO_3$

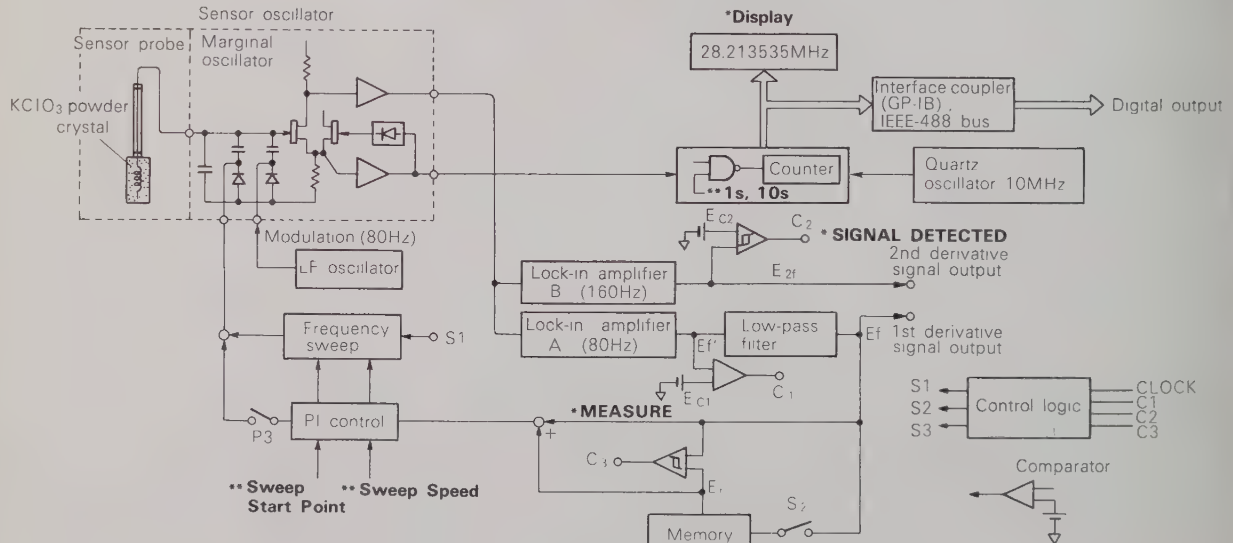
In a $KClO_3$ crystalline lattice, asymmetric charge distribution produces an electric-field gradient, and the chlorine nucleus $Cl^{35}$ precesses around this electric-field gradient. The chlorine nucleus has a nuclear spin of 3/2, and negative quadrupole moment. Only two orientations of the spin axis are allowed. The corresponding values of angular momentum have distinct magnetic quantum numbers. Energy separation of these (two) momentum levels, and the frequency of transitions between them, are proportional to the electric-field gradient. In a $KClO_3$ crystalline lattice, the electric-field gradient decreases with increasing temperature due to molecular vibration, thus the resonant frequency is temperature-sensitive.

The temperature-dependence of the NQR frequency is shown in the figure at right. The NQR frequency range corresponding to temperatures from 10 to 450 K is about 27 to 29 MHz. The temperature coefficient of frequency is about 5 kHz/K at room temperature, and digital temperature measurement from 90 to 398 K is possible. The instrument is used with a computer or calculator, to convert the frequency output to temperature.



*Temperature dependence of NQR frequency of $Cl^{35}$ in $KClO_3$*

## BLOCK DIAGRAM OF NQR THERMOMETER



* Front panel indicator
** Front panel setting

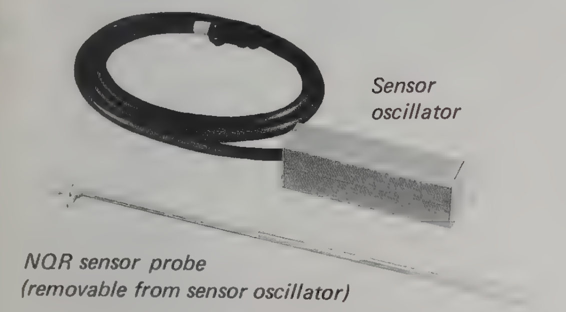
## PRINCIPLE

A block diagram of the NQR thermometer is shown on page 2. Powdered $KClO_3$ crystals are contained in a cylindrical cavity at the end of a stainless steel tube. The crystals are in the electromagnetic field of a FET type marginal oscillator tank coil. When the coil is tuned to the NQR resonance frequency of the sample, the Q factor of the coil falls and the oscillator output amplitude reduces.

The marginal oscillator is frequency-modulated at 80 Hz in a narrow band about the NQR absorption frequency, this amplitude-modulates its output. (The 80 Hz amplitude-modulated signal is detected by lock-in amplifier A and used to center the oscillator frequency on the NQR absorption band. The 160 Hz second-harmonic frequency is detected by lock-in amplifier B and used to confirm oscillator lock-in to the NQR frequency.)

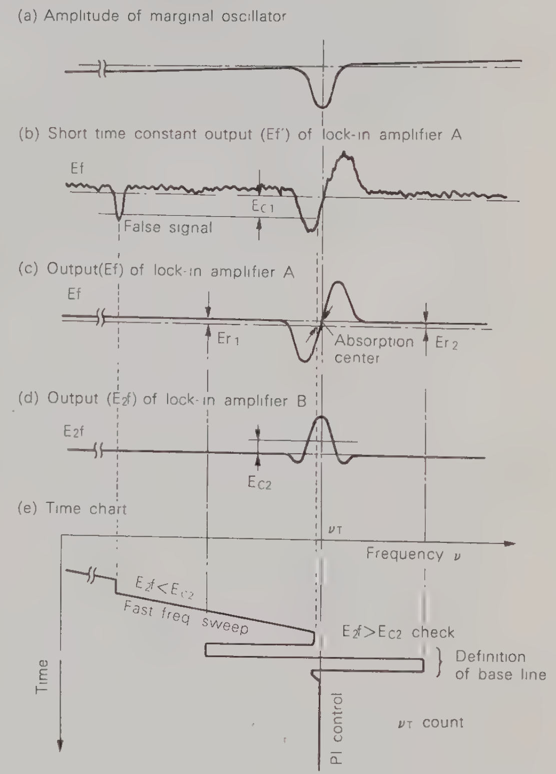
The operating procedure is as follows (see waveform figures):

First the frequency of the marginal oscillator is swept to find the absorption band. When lock-in amplifier A output $E_{f'}$ exceeds a preset level $Ec_1$, the sweep stops and the output $E_{2f}$ of lock-in amplifier B is checked. If the output exceeds a preset level $Ec_2$, the oscillator is in the absorption band; (otherwise, sweeping continues).



**Type 2578-01 NQR probe**

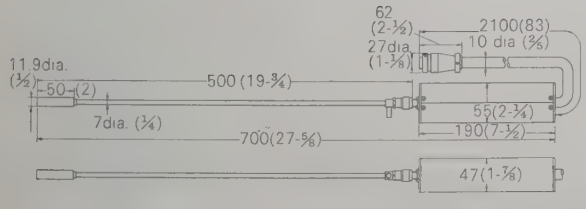
Next the "base line" is defined: amplifier output values $Er_1$ and $Er_2$ at relative frequencies ±f are checked. The average of these values, reference voltage Er, is used to define the center of the absorption band (figure, part c) and the Automatic Frequency Control (AFC) loop is closed.


(a) Amplitude of marginal oscillator
(b) Short time constant output (Ef') of lock-in amplifier A
Ef
Ec1
False signal
(c) Output(Ef) of lock-in amplifier A
Ef
Er1
Absorption center
Er2
(d) Output (E2f) of lock-in amplifier B
E2f
Ec2
(e) Time chart
νT
Frequency ν
Time
E2f<Ec2
Fast freq sweep
E2f>Ec2 check
Definition of base line
PI control
νT count

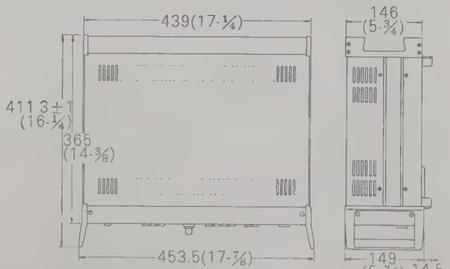
*Automatic detection of NQR frequency*

## DIMENSIONS

Unit: mm (approx. inch)



*Type 2578-01 NQR probe*



*Type 2571 NQR standard thermometer*

## SPECIFICATIONS OF NQR STANDARD THERMOMETER

**Temperature Range:** 90 to 398 K (−183 to +125°C).

**Measurand:** Liquids which must be compatible with Type 2578-01 NQR sensor probe (probe tip . . . gold-plated permalloy, coaxial tube . . . JIS SUS 316L stainless steel).

**Principle:** Automatic detection of Nuclear Quadrupole Resonance (NQR) absorption frequency system.

**Data Display:**

| Averaging Time | Data Display (NQR frequency of $KClO_3$) | Resolution | Unit Mark |
|---|---|---|---|
| 1 second | 7-digit in-line LED readout with decimal point | 10 Hz | MHz |
| 10 seconds | 8-digit in-line LED readout with decimal point | 1 Hz | |

**Measurement Annunciators:**

FREQUENCY SWEEP . . . Lights during frequency sweep to find NQR absorption signal.

SIGNAL DETECTED . . . Lights when NQR signal (2nd derivative signal) is detected.

REFERENCE SET . . . Lights to confirm the NQR absorption center.

MEASURE . . . Lights while NQR absorption frequency is in lock.

NQR SIGNAL OUT . . . Lights while analog output of NQR signal is delivered to external instrument.

NQR SIGNAL Meter . . . Monitoring meter for NQR signal (1st derivative signal).

**Interchangeability Accuracies for NQR Probes (Without Recalibration for Each Probe):** ±10Hz at the triple point of water, and at standard reference conditions.

**Reproducibility:**

| Averaging Time | Reproducibility at the triple point of water | Conditions |
|---|---|---|
| 1 second | Less than 20 Hz | Standard deviation of 50 time measurements at reference conditions |
| 10 seconds | Less than 6 Hz | |

**Standard Reference Conditions:** Ambient temperature . . . 23±1°C, humidity range . . . 45 to 75%, power supply voltage . . . within ±1% of rated value, magnetic field intensity . . . less than 80A/m, vibration . . . less than 0.1G, reference frequency . . . 10 MHz±0.1Hz, after check by REFERENCE SET.

**Maximum Follow-Up Rate for Measurand Temperature Fluctuations:** 1 mK/minute.

**Response Time:** Within 20 minutes (to reading within ±10Hz of final value, at 300mm length of NQR probe tip immersed in water triple-point cell).

**Averaging Time:** 1 or 10 seconds.

**Sampling Time:** 1.1 or 10.1 seconds, or HOLD.

**Sweep Speed:** FAST . . . approx. −2kHz/second, SLOW . . . approx. −1kHz/second.

**Sweep Start Point:** Variable from 27.4 to 29 MHz.

**Measurement Control Modes:**

START . . . Frequency sweep start.

RESET . . . Returned to the frequency sweep start point.

REF SET . . . Manual setting to detect the absorption center of NQR signal (1st derivative signal).

**Digital Data Output:** NQR frequency signal by ASC II (American Standard Code for Information Interchange) code through 24-contact connector, type of output . . . General Purpose Interface Bus (GP-IB, IEEE Standard 488-1975), output signal level . . . logic 0: 0 to +0.5V, logic 1: +2.4 to +5V(open collector signal).

**Warmup Time:** Approx. one hour.

**Operating Temperature Range:** 5 to 40°C (41 to 112°F).

**Storage Temperature Range:** −25 to 70°C (−13 to 158°F).

**Maximum Probe Environment Temperature:** 125°C.

**Humidity Range:** 20 to 80% relative humidity.

**Dielectric Strength:** 1,500V AC for one minute between power line and case.

**Insulation Resistance:** More than 100MΩ at 500V DC between power line and case.

**Power Consumption:** Approx. 40 VA (includes NQR probe).

**Power Requirements:** 100, 120, 200, 220 or 240V AC ±10% (must be specified), 47 to 63Hz.

**Panel and Case Colors:** Front panel . . . green-yellow (Munsell 2.5GY 7/1), outer case . . . green-yellow (Munsell 2.5GY 4/1).

**Dimensions:** Type 2571 . . . approx. 149 x 439 x 365mm (5-7/8 x 17-1/4 x 14-3/8″).

**Weight:** Types 2571 and 2578-01 . . . approx. 13.0kg (28.7 lbs).

**Accessories supplied at no extra cost:** Power cord (2- or 3-prong type) . . . 1 set, fuses . . . 2 pcs.

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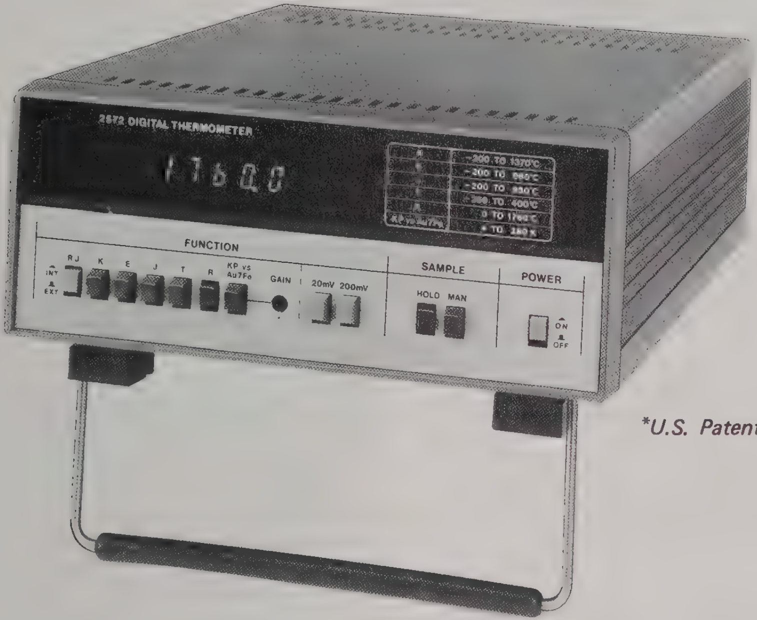
# 2572 & 2575 Digital Thermometers

## 2572



**U.S. Patent: 3,500,109 (Integrating analog-to-digital converter usable in digital voltmeters)*

The Type 2572 is a precision 4-1/2 digit thermocouple thermometer designed for bench-top or cord-free portable use. It provides a pushbutton selection of any of the five most used thermocouple types plus a new single type low-temperature thermocouple and two voltage ranges. To ensure exceptionally high reliability and stability, high-quality, all solid-state components such as LSI chips for the A-to-D converter and counter, ROM for digital linearization and LED display are used.

Options include digital output and a 12V DC rechargeable Ni-Cd battery. For the selection of 30-point thermocouple inputs, multi-channel switch is available as an accessory unit.

## FEATURES

- **Accepts five thermocouple types conforming to ANSI (or JIS) standards, and a new single type of cryogenic thermocouple conforming to journal of research of NBS**
  Compatible thermocouples are of the following materials—R, K, J, T, E and KP vs Au7Fe.
- **Extremely low temperature measurement in unit Kelvin**
  Temperature range from 4 to 280K using a commercial low-temperature thermocouple, a combination of KP (a particular Nickel-Chromium alloy) versus Gold-0.07 at % Iron, which conforms to NBS (Journal of Research of the National Bureau of Standards — A Physics and Chemistry Vol. 76A, No. 3, May-June 1972). This thermocouple material has excellent sensitivity in the liquid helium and liquid hydrogen temperature range and a nearly linear thermovoltage. Low temperature ranges are useful for diverse fields such as scientific, energy, including liquefied gas, and various alloy industries.
- **Drift-free digital linearization programmed by ROM**
  Digital linearization provides excellent noise rejection and eliminates errors due to drift.
- **Highly-accurate internal reference junction compensation by semiconductor**
  Compensation accuracy is within ±0.2°C or ±0.3°C. No external reference junction compensation is required for all types of thermocouples.
- **Open thermocouple indication**
  Display flashes to indicate broken or faulty thermocouple or open input therminals.
- **Optional BCD output**
- **Power line or rechargeable Ni-Cd battery (optional) operation**
- **Two voltage ranges — 20mV/200mV with 1$\mu$V/10$\mu$V resolution**
- **Single-touch pushbutton operation**
- **Accessory multi-channel switch for pushbutton selection of up to 30-point thermocouple inputs**

## SPECIFICATIONS OF 2572

### Range, Accuracy and Resolution:

Temperature

| Type of Thermocouple | | Temperature Range | Resolution | Accuracy (At 23 ± 3°C. Not Including Reference Junction Compensation) | | |
|---|---|---|---|---|---|---|
| ***JIS (257210) | **ANSI (257210) | | | Applicable Temperature Range | 30-Day Calibration Cycle | 90-Day Calibration Cycle |
| R | R Platinum 13% Rhodium/ Platinum | 0 to 1769°C (JIS)<br>0 to 1760°C (ANSI) | 0.1°C | 0 to 600°C | ± (0.03% of rdg + 0.5°C) | ± (0.05% of rdg + 0.5°C) |
| | | | | 600 to 1769°C (JIS) | ± (0.03% of rdg + 0.2°C) | ± (0.05% of rdg + 0.2°C) |
| | | | | 600 to 1760°C (ANSI) | ± (0.03% of rdg + 0.3°C) | ± (0.05% of rdg + 0.3°C) |
| K | K Nickel Chromium/ Nickel Aluminum | –200 to 1370°C | 0.1°C | –200 to –100°C | ± (0.03% of rdg + 1°C) | ± (0.05% of rdg + 1°C) |
| | | | | –100 to 100°C | ± (0.03% of rdg + 0.3°C) | ± (0.05% of rdg + 0.3°C) |
| | | | | 100 to 1370°C | ± (0.03% of rdg + 0.2°C) | ± (0.05% of rdg + 0.2°C) |
| J | J Iron/ Constantan | –200 to 900°C (JIS)<br>–200 to 980°C (ANSI) | 0.1°C | –200 to –130°C | ± (0.03% of rdg + 0.8°C) | ± (0.05% of rdg + 0.8°C) |
| | | | | –130 to 0°C | ± (0.03% of rdg + 0.3°C) | ± (0.05% of rdg + 0.3°C) |
| | | | | 0 to 900°C (JIS)<br>0 to 980°C (ANSI) | ± (0.03% of rdg + 0.2°C) | ± (0.05% of rdg + 0.2°C) |
| T | T Copper/ Constantan | –250 to 400°C | 0.1°C | –250 to –200°C (ANSI) | ± (0.03% of rdg + 1°C) | ± (0.05% of rdg + 1°C) |
| | | | | –200 to 0°C | ± (0.03% of rdg + 0.4°C) | ± (0.05% of rdg + 0.4°C) |
| | | | | 0 to 400°C | ± (0.03% of rdg + 0.2°C) | ± (0.05% of rdg + 0.2°C) |
| E | E Nickel Chromium/ Constantan | –200 to 980°C | 0.1°C | –200 to –150°C | ± (0.03% of rdg + 0.6°C) | ± (0.05% of rdg + 0.6°C) |
| | | | | –150 to –20°C | ± (0.03% of rdg + 0.3°C) | ± (0.05% of rdg + 0.3°C) |
| | | | | –20 to 980°C | ± (0.03% of rdg + 0.2°C) | ± (0.05% of rdg + 0.2°C) |
| *KP vs Au7Fe | Chromel/Gold-0.07 at % Iron | 4 to 280K | 0.1K | 4 to 280K | ± (0.03% of rdg + 0.2K) | ± (0.05% of rdg + 0.2K) |

Notes: *1. The thermocouple of KP vs Au7Fe conforms to the Journal of Research of the NBS (National Bureau of Standards, U.S. Department of Commerce)-A Physics and Chemistry Vol. 76A, No.3 [Low Temperature Thermocouples: KP, "normal" silver, and copper versus Au-0.02 at % Fe and Au-0.07 at % Fe].

**2. ANSI (American National Standards Institute)-MC96.1-1975. [Temperature Measurement Thermocouples].

***3. JIS (Japanese Industrial Standards) C 1602-1981 [Thermocouples].

4. Calibrated to the thermoelectric voltage specified in Temperature-EMF tables in each standard.

DC Millivolt

| Range | Measuring Range | Resolution | Accuracy (At 23 ± 3°C) | |
|---|---|---|---|---|
| | | | 30-Day Calibration Cycle | 90-Day Calibration Cycle |
| 20mV | 0 to ± 19.999mV | 1 $\mu$V | ± (0.03% of rdg + 2 digits) | ± (0.05% of rdg + 2 digits) |
| 200mV | 0 to ± 199.99mV | 10 $\mu$V | ± (0.02% of rdg + 1 digit) | ± (0.04% of rdg + 1 digit) |

**Reference Junction Compensation:** Internal reference junction compensation (INT RJ) or external reference junction compensation (EXT RJ) by pushbutton selection. INT RJ by means of semiconductor mounted in instrument terminal at the following accuracy:

| Type of Thermocouple | Internal Compensation Accuracy |
|---|---|
| R | ±0.3°C |
| K | ±0.2°C |
| J | ±0.2°C |
| T | ±0.2°C |
| E | ±0.2°C |
| KP vs Au7Fe | ±0.3 K |

Note: At an ambient temperature of 5 to 40°C

**Measurement Method:** Feedback pulse width modulation counting method (integrating type)

**Type of Display:** LED (light-emitting diode) display

**Maximum Indication:** 19999

**Overrange Indication:** Display flashes when input voltage exceeds the temperature range

**Open Thermocouple Indication:** Display flashes when thermocouple opens

**Unit Marks:** mV, °C and K

**Polarity Indication:** Negative mark (–) only

**Thermocouple and Voltage Range Selection:** Pushbuttons

**Linearization:** Digital linearization by ROM program

**Number of Segments:** Up to 94 segments for R, 62 for K, 58 for J, 53 for T, 63 for E and 119 for KP vs Au7Fe

**Response Time to Rated Accuracy:** 1.5 seconds

**Sampling Rate:** Approx. 2 times/second and HOLD (remote control possible by external contact or TTL-level signal)

**Warmup Time:** Approx. 30 minutes

**Input Impedance:** More than 10MΩ

**Input Current:** Less than 500pA

**Maximum Input Voltage:** 50V DC between H and L input terminals, 250V DC or 250V AC (rms) between input terminals and case, and between guard terminal and case

**Common Mode Rejection:** More than 140dB at 50/60Hz with 1kΩ source impedance unbalance and application of 100V AC

**Temperature Coefficient:**

| Range | Temperature Coefficient |
|---|---|
| R | ±(0.005% of rdg + 0.06°C) /°C |
| K | ±(0.005% of rdg + 0.03°C) /°C |
| J | ±(0.005% of rdg + 0.02°C) /°C |
| T | ±(0.005% of rdg + 0.02°C) /°C |
| E | ±(0.005% of rdg + 0.02°C) /°C |
| KP vs Au7Fe | ±(0.005% of rdg + 0.05K) /°C |
| 20mV | ±(0.005% of rdg + 0.003% of F.S.) /°C |
| 200mV | ±(0.005% of rdg + 0.002% of F.S.) /°C |

Note: At an ambient temperature of 5 to 20°C, or 26 to 40°C.

**Normal Mode Rejection:** More than 80dB at 50/60Hz

**Operating Temperature Range:** 5 to 40°C (41 to 104°F)

**Humidity Range:** 20 to 80% (relative humidity)

**Dielectric Strength:** 1,500V AC for one minute between power line and case, between H,L, guard terminals and case, and between H,L, guard terminals and power line

**Insulation Resistance:** More than 50MΩ at 500V DC between power line and case, between H,L, guard terminals and case, and between H,L, guard terminals and power line

**Power Supply:** AC line operation (standard) . . . 100, 115, 200, 215 or 230V AC ±10% (must be specified)

Battery operation (optional) . . . . . 12V DC rechargeable Ni-Cd battery (JIS C 8501 Type SUM-2). Approx. three hours of continuous operation with a recharging time of 15 hours

**Power Consumption:** Approx. 18VA

**Dimensions:** Approx. 88 x 215 x 328mm (3-1/2 x 8-1/2 x 12-7/8")

**Weight:** Approx. 5.0kg (11.0 lbs)

**Accessories supplied at no extra cost:**

| | |
|---|---|
| Power cord (2- or 3-prong type) | 1 set |
| Fuses (0.5A) | 2 pcs. |
| Fuses (2A) | 2 pcs. |

**Types Available:**

| Name | Code | Description |
|---|---|---|
| Digital Thermometer (Without BCD output) | **257210** | ANSI or JIS (°C) |

**Optional Features for Type 2572:**

| Code | Name |
|---|---|
| **257920** | BCD output |
| **B9264FS** 289908 | Rechargeable Ni-Cd battery. |

**Accessory Unit for Type 2572:**

| Code | Name |
|---|---|
| **281501** | Multi-channel switch |

Note: For specifications of Type 281501, refer to the back cover.

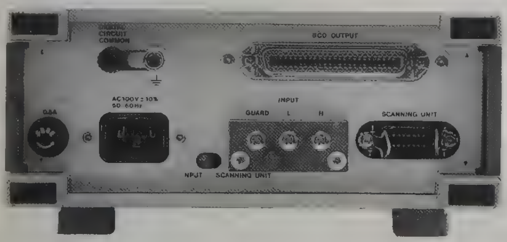
## OPTIONAL FEATURES FOR 2572

To expand the versatility of Type 2572, digital output and rechargeable Ni-Cd battery are available as optional features. Using a BCD output, Type 2572 is adaptable for a data processing system or a digital printer. To provide full portability, a rechargeable Ni-Cd battery can be inserted into Type 2572 to give it three hours of continuous operation between charges.

### ■ BCD Output (Code 257920)

**Input/Output Level**

| Signal | | Level "0" | Level "1" | Data |
|---|---|---|---|---|
| Input | BCD, Overrange, Unit Mark, Polarity, Decimal Point | 0 to 0.5V | More than +2.4V | H |
| | Busy | | | L |
| | End Pulse | | | L |
| Out-put | EXT Start | 0 to 0.5V | +2.4V to 5V | L |
| | EXT Hold | | | L |

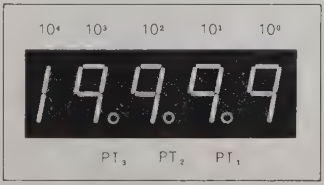


*Rear Panel of 2572*

**BCD Output Connector Contact Functions (Optional) (AMPHENOL 57-30500)**

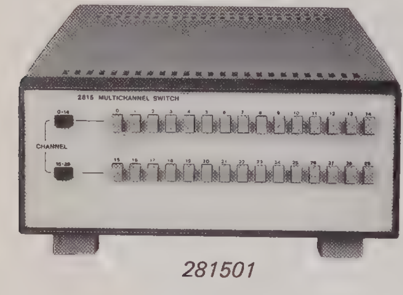
| Pin No. | | | |
|---|---|---|---|
| 1 | 1 | x $10^0$ | BCD output |
| 2 | 2 | | |
| 3 | 4 | | |
| 4 | 8 | | |
| 5 | 1 | x $10^1$ | |
| 6 | 2 | | |
| 7 | 4 | | |
| 8 | 8 | | |
| 9 | 1 | x $10^2$ | |
| 10 | 2 | | |
| 11 | 4 | | |
| 12 | 8 | | |
| 13 | 1 | x $10^3$ | |
| 14 | 2 | | |
| 15 | 4 | | |
| 16 | 8 | | |
| 17 | 1 | x $10^4$ | |
| 18 | | | |
| 19 | | | |
| 20 | | | |
| 21 | | | |
| 22 | | | |
| 23 | | | |
| 24 | EXT Start | | |
| 25 | EXT Hold | | |

| Pin No. | | |
|---|---|---|
| 26 | | Unit mark |
| 27 | | |
| 28 | °C | |
| 29 | | |
| 30 | K | |
| 31 | | |
| 32 | | |
| 33 | | |
| 34 | mV | |
| 35 | | |
| 36 | | |
| 37 | | |
| 38 | Overrange | |
| 39 | | Polarity |
| 40 | – | |
| 41 | | |
| 42 | Pt 1 | Decimal point |
| 43 | Pt 2 | |
| 44 | Pt 3 | |
| 45 | | |
| 46 | | |
| 47 | Busy | |
| 48 | End Pulse | |
| 49 | Common | |
| 50 | + 5V | |



## 281501 MULTI-CHANNEL SWITCH (ACCESSORY UNIT FOR 2572 & 2575)

Types 2572 and 2575 measure up to 30 channels of temperature when used with Type 281501 Multi-Channel Switch. Type 281501 contains 30 channel pushbutton selector switches on the front panel, and any combination of 30 thermocouples can be connected to this unit.



*281501*

**Number of Channels:** 30.
**Channel Selection:** Manual.
**Accuracy:** Temperature (includes emf of selector switch and terminals) . . . ±0.2°C for K, J, T and E, ±0.4°C for R, DC mV (selector switch changeover error) . . . Within ±1μV.
**Reference Junction Compensation:** Internal reference junction compensation by semiconductor.
**Input Connection:** 3-wire screw terminal connection.
**Dielectric Strength:** 1,500V AC for one minute between internal circuit and case.
**Insulation Resistance:** More than 50MΩ at 500V DC between internal circuit and case.
**Accessory supplied at no extra cost:** Interconnection cord to 2575 (0.3m long) . . . 1 set.

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# 2573
# Digital Thermometer

## Miniature, Fully Portable Thermometer — Small Size 52x142x150mm in Weight 0.7kg

*257342*

52 x 142 x 150 mm 0.7 kg including battery
(2-1/8 x 5-5/8 x 5-7/8" 1.5 lbs)

The Model 2573 is a handy, three-digit thermocouple thermometer that measures temperature from −60 to 500°C at an accuracy of ±(2°C + 1 digit) and a resolution of 1°C. It accepts input from Type K thermocouple probe — surface temperature, sheathed round tip, or user's probe (conforming to ANSI, BS, DIN or JIS standards).

**U.S.Patent 3,500,109 (Integrating analog-to-digital converter usable in digital voltmeters)*

## MAIN FEATURES

- **±(2°C + 1 digit) accuracy, 1°C resolution**
- **Two Type K thermocouple probes available**
  Surface temperature or sheathed round tip (sensitive length 200mm with 1.6 dia.) type.
- **Commercially-available Type K thermocouples also compatible**
  When an optional reference junction adapter is used.
- **YEW-original reference junction compensation circuit using semiconductor**
  Actual test data shows that the compensation accuracy is within 1°C at operating temperature range.
- **LCD (liquid-crystal display) for long life and clear visibility even in bright sunlight**
- **Interchangeable probes through fast, exact plug-in connection to the instrument**
- **Power line or rechargeable Ni-Cd battery operation**
- **Single-touch pushbutton operation**
- **Sample/hold mode selections**
- **Overrange and recharging indicators**
- **Patented A-D converter of excellent noise performance and stable operation**
- **Outstanding reliability and maintainability**

**Accessories for 2573**

| Description | Item | | Code |
|---|---|---|---|
| Standard | Carrying strap | | – |
| | Dust cover | | – |
| Optional | AC Adapter | 100V AC ±10%, 50 and 60Hz | **B9261VA**<br>257980 |
| | | 120V AC ±10%, 60Hz | |
| | | 220V AC ±10%, 50 and 60Hz | |
| | Thermocouple probe | Surface temperature probe (K) | **257841** |
| | | Sheathed round tip probe (K) | **257842** |
| | Reference junction adapter | | **257930** |
| | Probe case | | **B9600LD**<br>257981 |

## SPECIFICATIONS

**Measurement Method:** Feedback pulse width modulation counting method (integrating type)

**Temperature Sensor:** Type K (nickel chromium versus nickel aluminium) probe selectable from two types (optional), NiCr-Ni thermocouple or equivalent (optional Code 257930 Reference Junction Adapter is required)

**Temperature Range:** - 60 to 500°C

**Resolution:** 1°C

**Accuracy:** ±(2°C + 1 digit) at an ambient temperature of 23 ±5°C (includes errors of reference junction compensator and linearizer)

**Type of Display:** 3-digit liquid-crystal display (LCD)

**Overrange Indication:** ––– display when input exceeds temperature range

**Sampling Rate:** Approx. 2 times/second and HOLD

**Response Time:** Approx. 2 seconds for the display from 0 to 500 (instrument only)

**Maximum Input Voltage:** 1V (peak-to-peak) when used with Code 257930 Reference Junction Adapter

**Source Impedance:** 500Ω (500Ω causes 1°C error)

**Reference Junction Compensation:** 5 to 40°C by means of semiconductor mounted in instrument terminal

**Temperature Coefficient:** ±1 digit/10°C

**Operating Temperature Range:** 5 to 40°C (41 to 104°F)

**Storage Temperature Range:** –20 to 40°C (–4 to 104°F)

**Humidity Range:** 20 to 80% (relative humidity)

**Common Mode Rejection:** More than 120dB at DC, 50 or 60Hz between chassis and input terminal (H or L) with 1kΩ impedance unbalance (when used with Code 287930 Reference Junction Adapter)

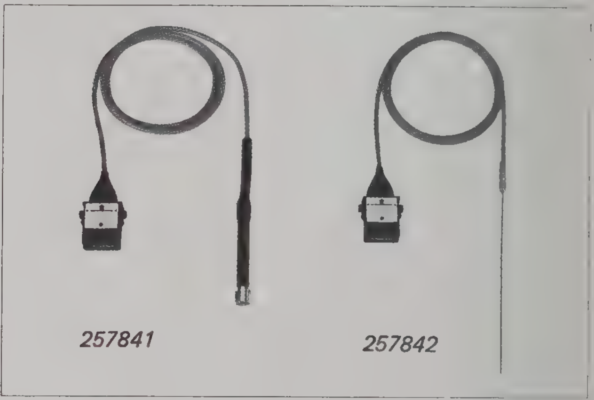
**Normal Mode Rejection:** More than 45dB at 10mV, 50 or 60Hz (when used with Code 257930 Reference Junction Adapter and Code 258710 Surface Temperature Probe)

**Power Source:** Battery operation . . . . 7.2 V DC rechargeable Ni-Cd battery. Approx. eight hours of continuous operation with a recharging time of 16 hours. Power pilot lamp extinguishes when recharging is necessary.
AC line operation . . . . 100, 120 or 220V AC±10% (must be specified), for both 50 and 60Hz, when using optional Code 257980 AC Adapter

- **Probes (optional accessories)**

| Code | 257841 | 257842 |
|---|---|---|
| Name | Type K thermocouple probe | |
| | Surface temperature probe | Sheathed round tip probe |
| Class or Accuracy | Class 0.75<br>(*JIS C 1602-1981) | Class 0.4<br>(*JIS C 1602-1981) |
| Maximum Applicable Temperature | 500°C (932°F) | 800°C (1,472°F) |
| Probe Size (Approx.) | 15 dia. x 106 mm<br>(0.59 dia. x 4-1/4") | 1.6 dia.x 200 mm<br>(0.06 dia. x 7-7/8") |
| Leadwire Length (Approx.) | 1.5 m (4.9 ft) | |
| Protection Tube | — | Stainless steel<br>(*JIS SUS 347) |
| Dielectric Strength | — | 500V AC for one minute between protection tube and circuit common |
| Insulation Resistance | — | More than 10MΩ at 500V DC between protection tube and circuit common |
| Reference Junction | Provided | |

*JIS ... Japanese Industrial Standards.



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# 2577
# Digital Hygrometer

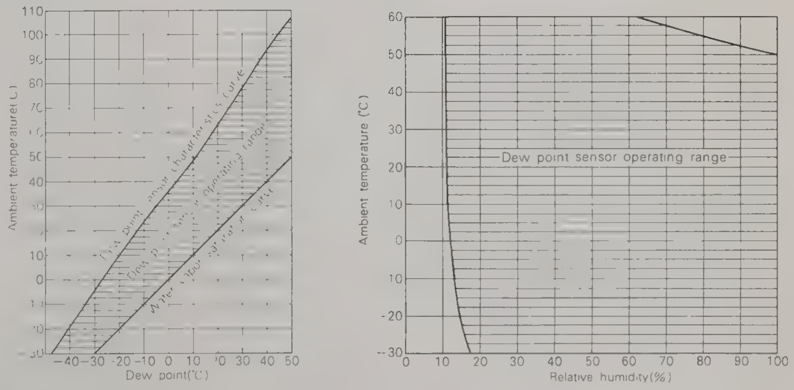
## Three-Function Digital Meter .....
## Measures Relative Humidity, Dew Point and Ambient Temperature

### MAIN FEATURES

- **Selection of three different functions:**
  Relative humidity — approx. 15 to 99.9%.
  Dew point — −45 to 50.0°C.
  Ambient temperature — −30 to 60.0°C.
- **Dew point and temperature sensors into a single compact probe**
  Type 2577's probe consists of dew point sensor and temperature sensor (semiconductor). Relative humidity is automatically calculated from the signals of two sensors, and displayed.
- **Minimum maintenance**
  Dew point sensor continuously operates without critical adjustment simply by impregnating its glass tape with lithium chloride solution about once every 3 months.
- **Rechargeable battery/power line operation**
  Rechargeable Ni-Cd battery is supplied with Type 2577 as a standard feature.
- **Analog outputs**
  Analog outputs are available as a standard feature for continuous recording of relative humidity, dew point and/or ambient temperature.
- **Single-touch pushbutton operation**
- **Durable, yet compact and lightweight ⌐ 4.0kg including battery**

The Type 2577 Digital Hygrometer has two types of sensors, a humidity-sensitive dew point sensor and a semiconductor temperature sensor, which enable it to measure relative humidity, dew point and ambient temperature.

The dew point sensor measures the moisture content of the air by utilizing the deliquescence of lithium chloride. In contrast to conventional wet and dry bulb psychrometers and hair element hygrometers, Type 2577 offers many advances, including portability, simple operation, convenient analog outputs, excellent reliability and stability with a minimum maintenance.



Dew point sensor measuring ranges

YOKOGAWA ◆
Bulletin 2577-E

## SPECIFICATIONS

**Measuring Ranges:**
AMBIENT TEMPERATURE . . . −30 to 60.0°C.
DEW POINT . . . −45 to 50.0°C.
(Notes) 1. Dew point measuring ranges are limited by ambient temperature. Refer to figures on the front page. 2. Dew points below 0°C are those measured over supercooled water.
RELATIVE HUMIDITY . . . Approx. 15 to 99.9%.
(Note) Relative humidity measuring ranges are limited by ambient temperature. Refer to figures on the front page.

**Accuracy:** At an ambient temperature of 23 ± 3°C.
(Includes interchangeability accuracies for probes)
AMBIENT TEMPERATURE . . . ±0.3°C.
DEW POINT . . . ±1°C.
RELATIVE HUMIDITY . . . ±[(7−0.04T)% of reading + 0.5% of full scale].
(Note) T: Ambient temperature in °C.

**Sensor Probe:** Probe consists of temperature sensor (semiconductor) and dew point sensor (using lithium chloride solution). Relative humidity is automatically calculated from the signals of the temperature and dew point sensors.

**Display:** 3-digit light-emitting diode (LED) display.

**Overrange Indication:** Display flashes when the input is out of range.

**Reading Rate:** Approx. 2 times/second.

**Measurand:** Air.
(Note) Instrument corrosion or measurement errors may occur when any of the following corrosive vapors or gases are contained in air; sulfuric acid, ammonia, chlorine, acid, alkali, acetylene, salt, glycol or triethanolamine.

**Ambient Draft Velocity:** Less than 0.25m/second.

**Temperature Coefficient:**
AMBIENT TEMPERATURE or DEW POINT . . . ±0.01°C/°C.
RELATIVE HUMIDITY . . . ±0.1% of reading/°C.

**Response Time:** Rise time (to dew point reading within ±1°C after POWER switch is set to ON) . . . Within 15 minutes.
Step response (time to reading within ±10% of fluctuation) . . . AMBIENT TEMPERATURE: approx. 7 minutes, DEW POINT; within 3 minutes (rise time), or within 10 minutes (fall time).

**Operating Position:** Horizontal, vertical or inclined.

**Analog Output:**
AMBIENT TEMPERATURE or DEW POINT data display . . . Analog outputs of both ambient temperature and dew point.
RELATIVE HUMIDITY data display . . . Analog outputs of both ambient temperature and relative humidity.
Output voltage . . . 10mV/digit (AMBIENT TEMPERATURE or DEW POINT), 5mV/digit (RELATIVE HUMIDITY).
Accuracy of analog output . . . Measurement accuracy ±15mV.
Load resistance . . . More than 100kΩ.

**Operating Temperature Range:** −20 to 40°C (−4 to 104°F), instrument only.

**Humidity Range:** 20 to 80% relative humidity (instrument only).

**Dielectric Strength:** 1,500V AC for one minute between case and power line, or between case and output terminals or probe.

**Insulation Resistance:** More than 100MΩ at 500V DC between case and power line, or between case and output terminals or probe.

**Power Requirements:**
Battery operation . . . 12V DC rechargeable Ni-Cd battery. Approx. 4 hours of continuous operation with recharging time of 20 hours.
AC line operation . . . 100, 120, 200, 220 or 240V AC ±10% (must be specified), 47 to 63Hz.

**Power Consumption:** Approx. 18VA (at POWER switch set to ON), 12VA max. (ordinary operation).

**Dimensions (Approx.):** Instrument . . . 100 x 210 x 230 mm (4 x 8-1/4 x 9-1/8″), sensor probe . . . 24 dia. x 230 mm (1 dia. x 9-1/8″).

**Weight (Approx.):** Instrument . . . 4.0 kg (8.8 lbs), sensor probe . . . 0.3 kg (0.7 lbs).

**Accessories supplied at no extra cost:**
257870 sensor probe (with 5m interconnection cord to 2577, 1 set), B9264FS (289908) Ni-Cd battery (1 pc.), lithium chloride solution (1 bottle, 30 cc), probe case (1 pc.), probe bracket (1 pc.), fuses (2 pcs. each of 0.5A and 2A), power cord (2- or 3-prong type, 1 set).

**Spares available at extra cost:**
257870 sensor probe, E9336FA (257990) lithium chloride solution (1 bottle, 30 cc), B9264FS (289908) Ni-Cd battery.

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# 2677 41
# Surface Temperature Indicator

Model 2677 is a thermoelectric temperature measuring instrument using a Type K thermocouple as a temperature detector. It is designed for easy and quick measurement of surface temperatures of metals and other materials of various configurations such as cylinders, drums, rolls, pipes, sheets and bearings.

The surface temperature of slowly moving materials can also be measured by this instrument. Two temperature measuring ranges are available: –10 to 300°C/–10 to 600°C, which are changeable with a switch.

## MAIN FEATURES

- **Unique temperature sensing element**
  Response is very fast as the temperature sensing element uses a thin belt-like thermocouple in a unique YEW configuration.
- **Accurate reference temperature compensation**
- **Shock-proof indicator**

## SPECIFICATIONS

**Indicator:** Moving coil type (taut band suspension type movement).

**Temperature Measuring Range:** –10 to 300°C/–10 to 600°C (dual ranges changeable with a switch).

**Minimum Scale Division:** 5°C/10°C.

**Accuracy:** ±2% of full scale value.

**Response Time:** Approx. 4 seconds.

**Type of Thermocouple:** Type K (Chromel-Alumel) thermocouple.

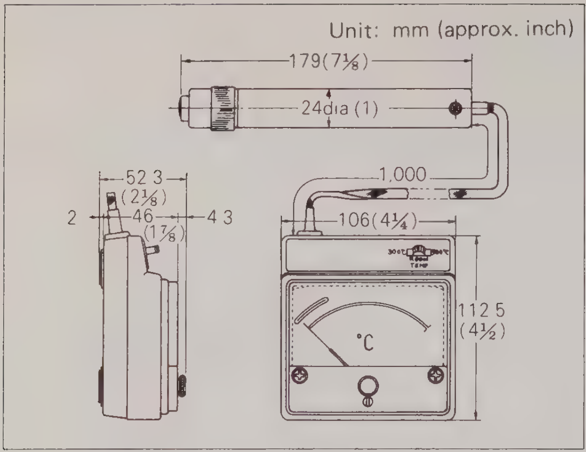
**Ambient Temperature Compensation:** By setting the indicator pointer to the mark of the thermometer provided on the indicator scale.

**Dimensions of Carrying Case:** Approx. 255 x 150 x 63mm (10 x 5-7/8 x 2-1/2").

**Weight:** Approx. 920g (2.0 lbs) including indicator, detector, leadwire and carrying case.

**Accessory supplied at no extra cost:** Carrying case . . 1 pc.

## DIMENSIONS



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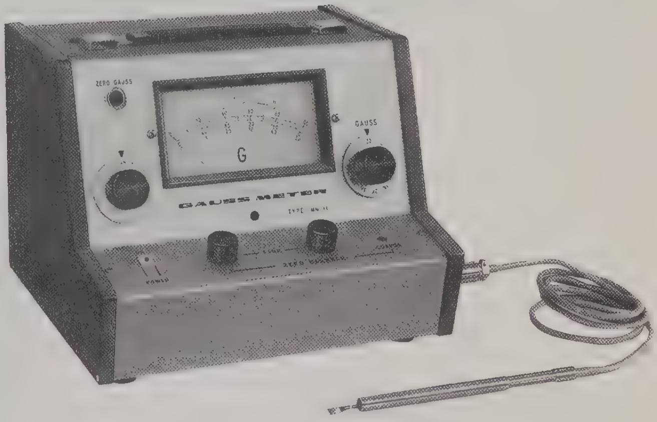
# 3251 Gauss Meter
# 3254 Electronic Fluxmeter

## 3251

Type 3251 is a portable type gauss meter which determines the magnetic flux density and polarity of magnetic poles by using a germanium Hall generator as a magnetic field detector. The magnetic flux density can be directly measured by merely inserting the probe into the magnetic field to be measured. The measuring range covers from 20 gauss to 20 kilo-gauss in 10 ranges, not only for DC magnetic fields but also for AC magnetic fields up to 500 Hz. In addition, it permits continuous recording of magnetic flux density and observation of waveforms when combined with a recorder or an oscilloscope.



194 x 250 x 235 mm 5 kg
(7-5/8 x 9-7/8 x 9-3/8" 11 lbs)

### SPECIFICATIONS

**Method of Measurement:** Constant current drive system with germanium Hall generator probe.
**Measuring Range:** 20/50/100/200/500/1,000/2,000/5,000/10,000/20,000 gauss.
**Frequency Range:** DC to 500 Hz.
**Polarity Indication:** N and 5 polarities.
**Accuracy:** ± 2.5% of full scale at DC or 50 to 60 Hz.
**Frequency Characteristics:** Variation of indication is within ± 3% over measuring frequency range.
**Ambient Temperature Influence:** Variation in indication is within ± 3% of indicated value for ambient temperature variation of 20 ± 20°C.
**Variation of Zero-Point Indication:** Unrecognizable in the range of 50 to 20,000 gauss (within 2% of full scale only for 20 gauss range).
**Scale:** Uniform 50 divisions with N and 5 polarity marks.
**Calibration:** No calibration of full scale is required for use in combination with YEW probes. Zero gauss is easily calibrated with the aid of zero gauss chamber on the front panel.
**Output:** Recorder output — approx. 10 mV (internal resistance, approx. 500 Ω, DC magnetic field only), Oscilloscope output . . . modulated wave including 1 kHz carrier signal, approx. 0.4 V-pp (load resistance of more than 1 kΩ).
**Power Requirements:** 100, 115, 200 or 230 V AC ± 10% (must be specified), 50 or 60 Hz
**Accessory furnished at no extra cost:** Reference magnet for flat probe (1,000 gauss) . . . 1 pc. (built in)
**Note:** Since no probe is supplied with Type 3251, please specity gauss meter probe shown in the right table when ordering Type 3251.

### OPTIONAL ACCESSORIES

**3252 Gauss Meter Probes**

| Name | Model | Dimensions of Hall Generator | Dimensions of Probe Element | Description |
|---|---|---|---|---|
| Flat probe | **325201** | 0.4x3.2x8.5mm | 0.15x1.2x2.5mm | For magnetic field measurement in narrow gaps and proximities |
| | **325202** | 0.8x3.2x8.5mm | 0.15x1.2x2.5mm | Sturdy and destruction resistive |
| Axial probe | **325203** | 5 dia.x105mm | 1.2x2mm | For magnetic field measurement in solenoid coils |

**325302 External standard magnet**
for use with Type 3252 Axial Probe
**Magnetic Flux Density:** 1,000 gauss.
**Accuracy:** ± 0.5%.

# 3254

260 x 180 x 117 mm 2.5 kg
(10-1/4 x 7-1/8 x 4-5/8″ 5.5 lbs)

The 3254 measures magnetic flux cutting a search coil and is widely used for general magnetic measurements such as determining the magnetizing force of permanent magnets, flux of magnetic circuits in various types of electrical equipment (except for alternating fields) without requiring auxiliary instruments. The 3254 Electronic Fluxmeter consists of an integrator plus a battery-operated high-gain DC amplifier and a taut-band suspension type indicator.

## OPTIONAL ACCESSORIES

**3255 Search Coil**

Suitable search coils should be prepared and used in accordance with the application, that is, in consideration of location of the measuring point such as in a magnet or in an air gap, magnet configuration, magnitude of magnetic flux, etc.

Generally, the search coil is prepared by the user in accordance with his application.

Three kinds of search coils are available from YEW as optional accessories for the 3254 Electronic Fluxmeter:

| Name | Model | Number of Turns | Inside Area of Coil | Resistance |
|---|---|---|---|---|
| Search Coil No. 1 | **325501** | 40 | 25 $\text{cm}^2$ | 2Ω |
| Search Coil No. 2 | **325502** | 100 | 6 $\text{cm}^2$ | 2Ω |
| Search Coil No. 3 | **325503** | 10 | 3 $\text{cm}^2$ | 2Ω |

## SPECIFICATIONS

**Measuring Range:** ±1 x $10^2$/3 x $10^2$/1 x $10^3$/3 x $10^3$/1 x $10^4$/3 x $10^4$/1 x $10^5$ kilo-Maxwell Turns.

**Scale:** −1.0-0-+1.0 (100 div.)/−3.0-0-+3.0 (120 div.) double graduation.

**Scale Length:** Approx. 130 mm (Approx. 5-1/8″).

**Accuracy:** ±1% of full scale length (at 23 ± 5°C).

**Input Resistance:** 2 kΩ in 1 x $10^2$ kilo-Maxwell Turns range, 6 kΩ in 3 x $10^2$ to 3 x $10^3$ kilo-Maxwell Turns ranges, 20 kΩ in 1 x $10^4$ kilo-Maxwell Turns range, 60 kΩ in 3 x $10^4$ kilo-Maxwell Turns range and 200 kΩ in 1 x $10^5$ kilo-Maxwell Turns range.

**Temperature Coefficient:** Approx. ±0.5%/10°C.

**Drift:** Less than ±1% of full scale length per minute on 1 x $10^2$ kilo-Maxwell Turns range, and less than ±0.5% of full scale length per minute on other ranges.

**Hold Time:** The time required for the indication to vary by −1% after a magnetic flux change of full scale value is given:
More than 30 seconds on 1 x $10^2$ kilo-Maxwell Turns range, and more than 1 minutes on other ranges.

**Search Coil Resistance:** Less than 30 Ω for 1 x $10^2$ kilo-Maxwell Turns range, less than 75 Ω for 3 x $10^2$ to 3 x $10^3$ kilo-Maxwell Turns ranges, and less than 300 Ω for 1 x $10^4$ to 1 x $10^5$ kilo-Maxwell Turns ranges.

**Output Voltage:** ±5 mV DC/full scale.

**Output Resistance:** 100 Ω.

**Operating Temperature Range:** 0 to 40°C (32 to 104°F).

**Power Source:** Four 9 V batteries (JIS 006P, ANSI 6F22, Energieblock 9 V or equivalent).

**Battery Life:** Approx. 250 hours in continuous use.

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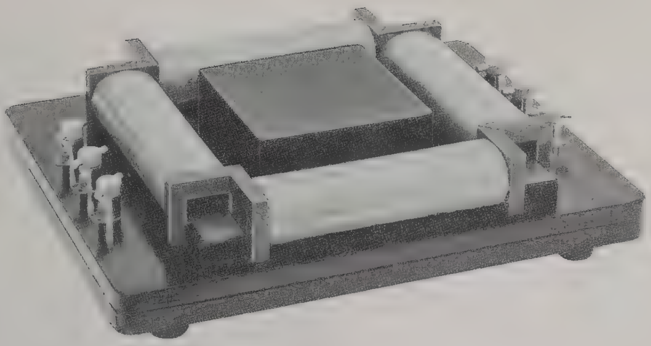
# 3265-3267
# 25cm Epstein Iron Loss Test Sets



*3265*
390 x 330 x 145 mm 8.3 kg
(15-3/8 x 13 x 5-3/4" 18.3 lbs)

Models 3265 to 3267 are designed for determining magnetic characteristics of electrical iron sheet by means of a stack of 3 cm x 30 cm long strip test specimens stacked around a 25 cm square frame. The testing method is specified in IEC, ASTM, JIS C2550 and other standards.

The test strips are stacked alternately on four sides of a square frame with their ends overlapping at the four corners so as to form a closed magnetic circuit. This permits determining, in combination with the appropriate indicating instruments, such characteristics of electrical iron sheet as iron loss (at commercial or audio frequencies) and magnetizing characteristics (at commercial frequencies or DC).

## SPECIFICATIONS

**Measuring Items and Range (at 50 or 60 Hz):** Magnetic flux density ... up to approx. 17 kilo-gauss, iron loss ... 0.5 to 10 W/kg, magnetizing force ... 1 to 100 Oe, permeability ... 100 to 10,000.

**Test Frames:**

| Measuring Power Source Frequency | Model | Max. Weight of Test Specimen | Primary Coil | Secondary Coil | Mutual Inductance |
|---|---|---|---|---|---|
| Commercial frequencies (50 or 60Hz) | **3265** | 2 kg | 700 turns, Approx. 0.6Ω | 700 turns, Approx. 2Ω | 850μH |
| | **3266** | 0.5 kg | 700 turns, Approx. 0.5Ω | 700 turns, Approx. 1.5Ω | 340μH |
| Audio frequencies (up to 10kHz) | **3267** | 0.2 kg | 352 turns, Approx. 0.4Ω | 352 turns, Approx. 0.4Ω | 150μH |

**Combination instruments**

**3268 Mutual Inductors**

Two kinds of mutual inductors are supplied as a pair. One for large currents (10A, Mutual Inductance: approx. 11 mH) and the other for small currents (1A, Mutual Inductance: approx. 180 mH).

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Bulletin 3265-E

## COMBINATION INSTRUMENTS

For DC magnetizing characteristics test
For iron loss test at audio frequency
For iron loss test at commerical frequency

<table>
<tr><th rowspan="2">Name</th><th rowspan="2">Model or Code</th><th colspan="5" rowspan="2">Specifications</th><th colspan="3">Combination</th></tr>
<tr><th>For iron loss test at commerical frequency</th><th>For iron loss test at audio frequency</th><th>For DC magnetizing characteristics test</th></tr>
<tr><td rowspan="3">Test Frame</td><td><b>3265</b></td><td colspan="5"></td><td>●</td><td></td><td>●</td></tr>
<tr><td><b>3266</b></td><td colspan="5"></td><td>●</td><td></td><td>●</td></tr>
<tr><td><b>3267</b></td><td colspan="5"></td><td></td><td>●</td><td></td></tr>
<tr><td>Mutual Inductor</td><td><b>3268</b></td><td colspan="5"></td><td>●</td><td></td><td></td></tr>
<tr><td rowspan="4">Portable standard single-phase low power factor wattmeter</td><td></td><td>Ranges</td><td>Current</td><td>Voltage</td><td>Power Factor</td><td>Internal Impedance</td><td rowspan="4">●</td><td rowspan="4"></td><td rowspan="4"></td></tr>
<tr><td><b>204121</b></td><td>1.2/2.4/6/12W</td><td>0.2/1A</td><td>30/60V</td><td>0.2</td><td>50Ω/V 31/1Ω</td></tr>
<tr><td><b>204122</b></td><td>6/12/30/60W</td><td>1/5A</td><td>30/60V</td><td>0.2</td><td>50Ω/V 1.7/0.06Ω</td></tr>
<tr><td></td><td colspan="5">Principle: Electro-dynamometer type. Accuracy: ±0.5% of full scale value.<br>Frequency Characteristics (at 45 to 60Hz): Variation in indication is less than ±0.2% of indicated value.</td></tr>
<tr><td rowspan="2">Portable precision rms ammeter</td><td><b>201603</b></td><td colspan="5">Principle: Moving coil type.<br>(vacuum thermocouple self-contained).<br>Accuarcy: ±1.0% of full scale value at 50 and 60Hz.<br>Frequency Coverage: DC, 10Hz to 1MHz.<br>Ranges: 100/200/500/1,000 mA.</td><td></td><td>●</td><td></td></tr>
<tr><td><b>201307</b></td><td colspan="5">Principle: Moving iron type.<br>Ranges: 20/10A.<br>Accuracy: ±0.5% of full scale value in effective measuring range.<br>Effective Measuring Range: From the rated value down to 20% of the rated value.</td><td>●</td><td></td><td></td></tr>
<tr><td>Portable precision flux voltmeter</td><td><b>2017</b></td><td colspan="5">Principle: Moving coil type with rectifier.<br>Ranges: 30/75/150/300 V.<br>Accuracy: ±0.5% of full scale value at 45 Hz to 10 kHz.<br>Frequency Coverage: 50 Hz to 10 kHz.</td><td>●</td><td>●</td><td></td></tr>
<tr><td>Portable precision rms AC voltmeter</td><td><b>201604</b></td><td colspan="5">Principle: Moving coil type.<br>(vacuum thermocouple self-contained).<br>Accuracy: ±0.5% of full scale value at 50 and 60 Hz.<br>Ranges: 15/30/75/150V.<br>Frequency Coverage: DC, 10Hz to 100 kHz.</td><td>●</td><td>●</td><td></td></tr>
<tr><td>Portable precision frequency meter</td><td><b>203831</b></td><td colspan="5">Range: 45 to 65 Hz (120/240V).<br>Accuracy: ±0.2% of full scale value.</td><td>●</td><td></td><td></td></tr>
<tr><td>Electronic fluxmeter</td><td><b>3254</b></td><td colspan="5">Ranges: 100 to 100,000 kilo-Maxwell Turns.<br>Accuracy: ±1%</td><td></td><td></td><td>●</td></tr>
<tr><td>Portable precision DC ammeter</td><td><b>2011</b></td><td colspan="5">Ranges: 0.1/0.3/1/3A.<br>Accuracy: ±0.5% of full scale value.</td><td></td><td></td><td>●</td></tr>
</table>

● : Required for respective test.

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# 3604
# Sound Level Meter

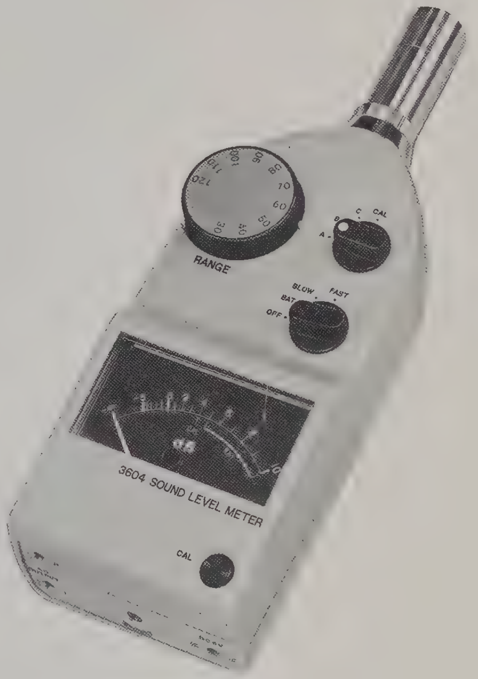
## Top-Quality Noise Measuring Instrument with One-Hand Operation

The YEW Type 3604 is a general-purpose sound level meter which makes noise level measurement from 30 to 130 dB (A-weighted), and designed to fulfill national and international standardization on sound measuring equipment such as IEC (International Electrotechnical Commission) Publication 651 for sound level meter, and JIS (Japanese Industrial Standard) C 1502 for sound level meter.

The YEW Sound Level Meter includes A, B and C frequency weighting circuits, and fast and slow meter damping. It employs a removable condenser microphone which provides stable sensitivity, excellent acoustic and temperature characteristics, and high noise immunity.

The sound level being measured is indicated in dB (decibels) by a high-reliable bezel meter. The bezel meter always gives a quick and sure reading with the aid of black scale and white pointer. Type 3604 fully uses ICs (Integrated Circuits), selected component and simplified circuits to enhance the reliability and serviceability. All components are packed into a streamlined, compact case.

The instrument is small enough to hold in one hand, and extremely easy to use. With its simple operation and true portability, Type 3604 Sound Level Meter is valuable for a wide variety of applications including industrial-, vehicle- and community-noise measurements, product noise control and investigation, and their assessments.



## FEATURES

- **Wide Dynamic Range—30 to 130 dB (A-Weighted)**
  Type 3604 can be used in a wide variety of environmental conditions, and makes almost all types of noise level measurements including from quiet residential district at night to jet plane on startup.
- **Tapered Front**
  Type 3604 is tapered at the microphone end in order not to disturb the sound field to be measured.
- **Simple-to-Operate**
  Operation is extremely simple. The instrument permits one-hand operation such as the selection of measuring range.
- **True Portability**
  Type 3604 is packed into a compact, rugged plastic case, and easily carried. It operates on either batteries or line power and weights 0.8 kg (1.8 lbs). The battery operation is convenient for outdoor measurements, and any place where an AC power line is not available.
- **AC Output for Simultaneous Recording**
  Output terminals are provided for use with recorders (load impedance; more than 600 Ω).
- **Windscreen and Carrying Case (Provided as Accessories)**
  For precision measurement, easy operation and transportation in outdoor use.
- **Easy-to-Read Bezel Meter**
  Despite being a small, handy instrument, the meter scale is maximized and tilted for an easy reading. To further enhance the scale visibility, the scale is colored in black, while pointer, scale graduations and markings are in white. Stable sensitivity is always assured by shock - and vibration-proof taut-band suspension system movement.

## SPECIFICATIONS

### General Specifications

**Conforms with Standards:** IEC (International Electrotechnical Commission) Publication 651 for sound level meter, JIS (Japanese Industrial Standard) C 1502 for sound level meter.

**Measuring Range:** 30 dB to 130 dB (A-weighted), 40 dB to 130 dB (B- and C-weighted).

**Frequency Range:** 31.5 Hz to 8,000 Hz.

**Attenuator:** 30 dB to 120 dB in ten 10 dB steps.

**Overall Noise Level:** 25 dB (A-weighted), less than 35 dB (B- or C-weighted).

**Weighting Networks:** A, B and C.

**Meter Scale:** Graduations from –5 dB to +10 dB.

**Meter Damping:** Fast and Slow.

**Calibration:** Calibrated at approx. 250 Hz (rectangular wave).

**Output Voltage:** Approx. 2V rms for full scale meter deflection.

**Output Impedance:** 600Ω ± 5%.

**Load Impedance:** More than 600Ω.

**Power Source:** Four 1.5V dry cells (JIS C 8501 UM-3 or equivalent), or 100V AC by using an optional Type 3622-10 AC Adapter (Other AC power supply voltages available upon request).

**Operating Temperature Range:** 5 to 40°C (41 to 104°F).

**Humidity Range:** 35 to 85%.

**Dimensions:** Approx. 255 x 88 x 60 mm (10 x 3-1/2 x 2-3/8").

**Weight:** Approx. 0.8 kg (1.76 lbs including microphone).

**Accessories supplied at no extra cost:**
Carrying case. . . . 1 pc., Instruction manual. . . 1 copy.

### Microphone

**Type:** Condenser microphone.

**Capacitance:** Approx. 30pF.

**Maximum Allowable Input Sound Pressure Level:** 140 dB.

**Sensitivity:** –54 dB ± 2 dB (0 dB = 1 V/μbar).

**Output Impedance:** Approx. 700Ω at 1 kHz.

**Bias Voltage:** Approx. 30V.

**Dimensions:** 24 mm diam. x 66 mm (7/8 x 2-5/8").

**Weight:** Approx. 0.1 kg (0.22 lbs.).

### Meter

**Principle:** Moving coil type (taut-band suspension system).

**Scale Length:** Approx. 66 mm (2-5/8").

**Point:** Knife-edge type (white).

**Scale Plate:** Black

**Graduations and Markings:** White.

**Scale Deflection:** 90°.

**Unit Mark:** dB.

**Front Dimensions:** Approx. 47 x 84 mm (1-7/8 x 3-3/8", including bezel).

## OPTIONAL ACCESSORIES

**B9663LA** (362210) **AC Adapter**
3604 can be operated from AC power line by using B9663LA.

**Power Supply:** 100±10V AC, 50 and 60Hz. Other power supply voltages available upon request.

**Output Voltage:** 5.6±1V DC.

**Max. Output Current:** 200 mA.

**Cord Length:** Approx. 2 m (6.6 feet).

**362311 Extension Cable**
The extension cable allows a remote mounting of microphone to the Sound Level Meter. It is used to reduce influence of sound reflection from meter.

**Cable Length:** Approx. 5 m (16.5 feet).

**362305 Tripod**
The tripod holds microphone or Sound Level Meter. An ordinary tripod on the market is also usable.

**362313 Microphone Stand**
Adapted for mounting microphone on a tripod.

**B9409JA** (289801) **Output Lead**

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